COMBUSTION

DEVOTED TO THE ADVANCEMENT OF STEAM PLANT DESIGN AND OPERATION

September, 1941

Night view of Longworth Station, Dayton, Ohio

Burning Bagasse as Fuel

Size Distribution in Pulverized Fuel and Stack Dusts

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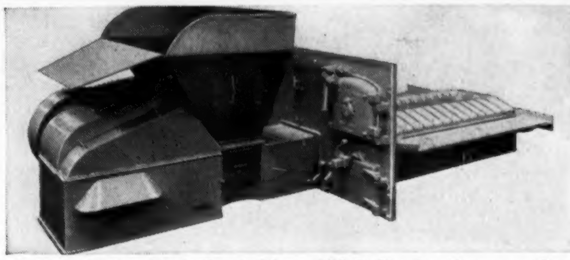
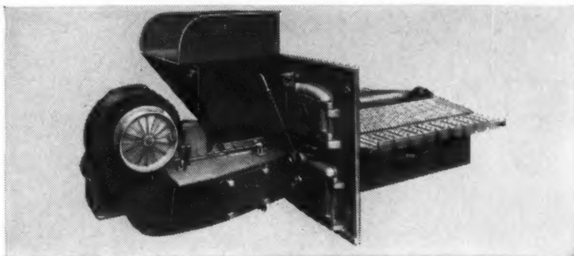
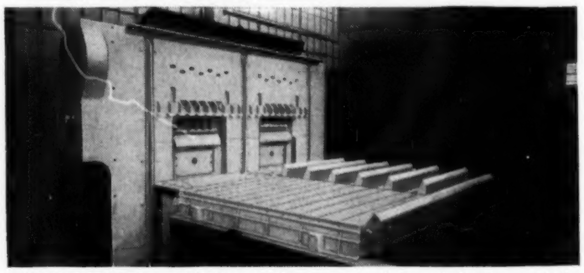


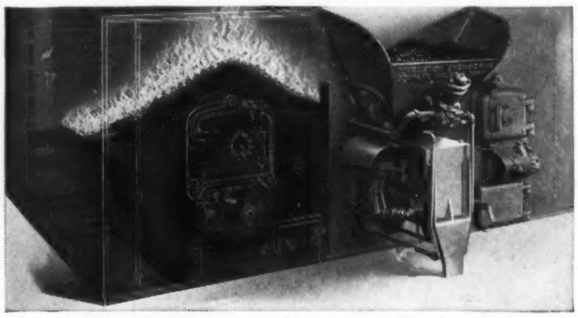
SKELLY STOKER — Underfeed; 20 to 200 boiler hp; burns anthracite or bituminous; has alternate fixed and moving grate bars; non-avalanching cantilever dump grates; integral forced-draft fan; sixteen rates of coal feed; automatic control; Timken bearings; Alemite lubrication.



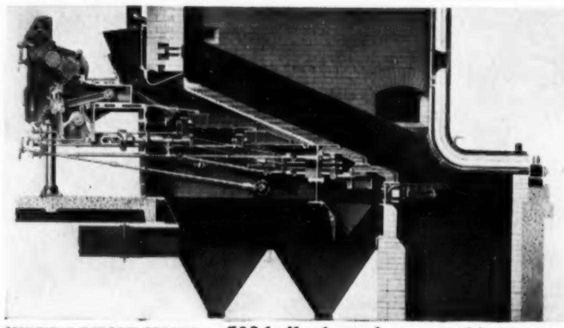
LOW RAM STOKER — Ram type, underfeed; 35 to 200 boiler hp; coking or non-coking bituminous; ideal for low-set, water-leg boilers; unit construction for easy installation, usually no foundation work; integral forced-draft fan and drive mechanism; ruggedly built; simple to operate.



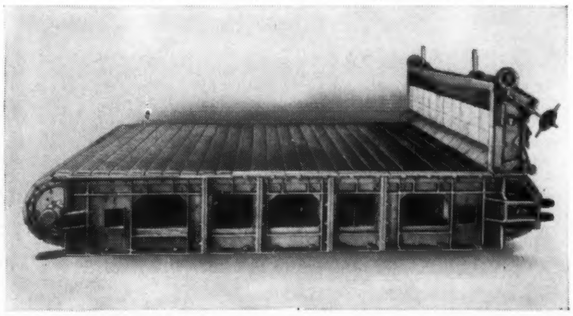
SPREADER STOKER — 150 hp to largest; variety of fuels; coal is fed in criss-cross streams; fines are burned in suspension, rest of coal on the grate, stationary or dumping; grate surface zoned for air control; wide control range for rate of feed and air supply.



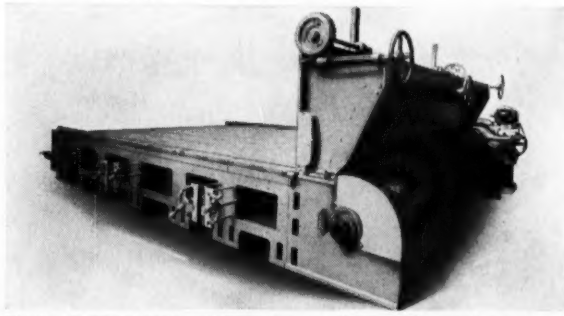
TYPE E STOKER — Underfeed; 150 to 600 boiler hp; variety of bituminous, especially caking and coking; ram feed; reciprocating sliding bottom; alternately fixed and moving, air-cooled grate bars providing for agitation of the fuel bed; zoned air control; over-fire air; steam, electric or hydraulic drive.



MULTIPLE-RETORT STOKER — 500 boiler hp to largest; coking or non-coking bituminous; all controls at front; sealed against siftings; reciprocating overfeed section; zoned air control; notable for uniform fire; ash disposal by steam dump, clinker grinder, continuous discharge.



TRAVELING GRATE STOKERS — Two types; 150 rated hp to units producing 200,000 lb of steam per hr or more; Coxe type is unequalled for small sizes of anthracite and coke breeze; also suited to lignite and some free-burning bituminous; both types forced-draft with zoned air control.



CHAIN GRATE STOKERS — Three types; from 150 rated hp up to units producing 275,000 lb of steam per hr or more; particularly well suited to the use of free-burning bituminous coals; available in either forced-draft or natural-draft designs.

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COMBUSTION

DEVOTED TO THE ADVANCEMENT OF STEAM PLANT DESIGN AND OPERATION

VOLUME THIRTEEN NUMBER THREE

CONTENTS

FOR SEPTEMBER 1941

FEATURE ARTICLES

EDITORIALS

DEPARTMENTS

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EDITORIAL

Maximum Coal Prices Sought

The Bituminous Coal Act was conceived primarily as a means of stabilizing an industry that for years had suffered from devastating competition within its own ranks, and the principal provision which won support from many producers was the establishment of minimum prices. Since putting into effect the revised schedules times have been too abnormal to afford a real test of the plan. However, that there have been numerous attempts to circumvent this provision by subterfuge or open violations is shown by the many "desist" orders and penalties imposed by the Bituminous Coal Division of the Department of the Interior.

While the Act did not specifically cover maximum prices there was wisely incorporated a provision establishing a Consumers' Counsel, charged with the duty of looking after the interests of the consumer. This Counsel now charges that many consumers are being subjected to excessive and oppressive coal prices in some markets, that graver abuses are threatened and that the only remedy is the immediate establishment of maximum prices. Accordingly, The Coal Division set September 9 as the date for the first hearing on these charges and for consideration of the proposal. If the charges of profiteering are substantiated, it is reasonable to expect that steps will be taken to formulate maximum prices; in which case, as in many others, a few by their actions will have been responsible for bringing about closer control of the industry.

The proposal would provide for maximum prices in terms of uniform increases above effective minimum prices, such as to yield a reasonable return above the "weighted average cost of producing coal in each district."

It is inevitable that special legislation set up to aid a particular industry must sooner or later react to restrict its freedom of action.

Spares and Replacements

The unprecedented speed-up in production, by reason of the defense program, has been reflected not only in the widespread demand for additional power equipment but also in the demand for replacement parts of all kinds. This is inevitable when many industrial plants have gone to two and three shifts which, while placing continuous heavy loads on existing equipment, has also seriously interfered with the customary scheduled outages for overhaul. Moreover, it is probable that in many instances management has been so engrossed in production problems that supervision of the power facilities has suffered; also to some extent skilled maintenance mechanics have been attracted to other fields.

Those who two or three years ago had the foresight to modernize and place their power plants in A-1 operating condition are now in a fortunate position, as are also those who stacked up an adequate supply of spare parts. The effort and expenditure involved were well invested. Today it is difficult enough to secure preference ratings on materials for parts urgently needed, and spares whose time of use is uncertain must be relegated to more distant deliveries.

Under the priorities set-up the situation has been aggravated by the procedure which necessitates the securing of priorities through each step from raw material to manufactured product as pertains to each individual order. Thus much loss of time is involved.

It is not to be inferred, however, that there have been widespread failures or shortcomings among industrial power facilities which, in fact, are meeting the increased burden exceptionally well; and thus far it has been possible to handle emergency cases through the cooperation of all parties concerned. But the peak of defense production has not yet been reached and the situation, as pertains to non-defense operations, is not likely to improve for some time. Therefore, those who can get along for the present will assist by being content with longer deliveries for spares.

Hydrogen Evolution in Steam Boilers

Deposits of black magnetic oxide of iron on turbine blades long ago suggested the dissociation of steam in the presence of hot metal within the boiler. This possibility was later confirmed by the laboratory work of several investigators, but it was generally believed that conditions within a boiler were unfavorable and the steam temperature too low to account for any appreciable reaction of this character. However, within the last two or three years a number of cases of boiler tube corrosion have been noted where it seemed certain that the feedwater was oxygen-free. Subsequent investigations led to the conclusion that the reaction between the steam and hot metal occurred in certain "starved" sections which, because of faulty circulation, were not full of water. Some of these cases were later reported in engineering society papers.

Inasmuch as hydrogen is liberated by the reaction it was logical that detection and measurement of the hydrogen while a boiler is in operation would reveal the presence and extent of this condition. Accordingly, equipment for this purpose has been devised by several manufacturers.

In the E. E. I. Prime Movers Committee Report on "Power Station Chemistry," published in July 1941, this subject is discussed at length, the detecting and sampling devices are described and statements covering the experiences of three operating companies are included. Its perusal is recommended to all those who have been or are likely to be confronted with this problem, for it is most important that such conditions which lead to ultimate failure be detected before the corrosion has progressed too far.

Burning BAGASSE as Fuel

By J. B. CRANE

Combustion Engineering Co., Inc.

Following a brief review of the production and characteristics of bagasse, the economics of its use as fuel are discussed and various types of furnaces, as employed in different localities, are described and compared. Present trends point to designs that will effect greater efficiency in burning where steam is required for uses in addition to sugar mill grinding.

THE world production of sugar for the year 1939–1940 was given as 18,460,000 metric tons from sugar cane and 11,646,000 metric tons from sugar beets, making a total of 30,106,000 metric tons.[1] The output of beet sugar ranges from 6 to 8 tons per acre in ten months and that of cane sugar 14 to 16 tons per acre in twenty months.[2] This means about 4,500,000 acres of land devoted to sugar.

Beet sugar is generally produced in those sections of the world where fuel is available and the refuse is used for feeding cattle. Cane sugar, on the other hand, is produced where fuel is expensive and difficult to secure. The cane is cut in the fields, the leaves and tops cut off and burned. The cane is then brought to the mill, ground in roller mills to remove the syrup and the refuse cane (bagasse) goes to the boiler room where it is used as fuel to produce steam for operating the mill.

Where the mill only grinds cane there usually is a surplus of bagasse for fuel, and efficiency in steam production is not essential. However, if the syrup is there refined or if irrigation pumping is required, then supplementary fuel may be necessary unless efficient methods are used to burn the bagasse. This has led to much interest in the development of modern designs for burning the fuel and the adoption of heat recovery equipment (economizers and air preheaters).

Sugar cane has a fibrous structure and an analysis much like wood. A representative analysis is compared with wood in Table 1.

TABLE 1—CHEMICAL COMPOSITION OF DRY WOODS AND OF BAGASSE*

	Carbon, per cent	Hydrogen, per cent	Nitrogen, per cent	Oxygen, per cent	Ash, per cent	Heating Value, Btu/Lb Dry	Heating Value, Btu/Lb	H_2O (as received)
Oak	50.16	6.02	0.09	43.36	0.36	8316		
Ash	49.18	6.27	0.07	43.91	0.57	8480		
Elm	48.99	6.20	0.06	44.25	0.50	8510		
Beech	49.06	6.11	0.09	44.17	0.57	8591	As Fired	
Birch	48.88	6.06	0.10	44.67	0.29	8586		
Fir	50.36	5.92	0.05	43.49	0.28	9063		
Pine	50.31	6.20	0.04	43.08	0.37	9153		
Average	49.56	6.11	0.07	43.83	0.42	8671		
Bagasse (Peru)†	49.00	5.89		43.33	1.75	8380	3860	53.9
Bagasse (Mexico)‡	47.3	6.08		35.24	11.32	9140	6400	...
Bagasse (Hawaii)†	46.3	6.07		45.30	2.33	8115	4707	42.00

* Based on data by Gootlieb, *Mark's Mechanical Engineers' Handbook.*
† Samples—1940 by Fuel Engineering Company of New York.
‡ Guayule—Rubber Plant of Mexico—1940 by Fuel Engineering Company of New York.

Bagasse varies slightly due to type of plant, ground in which it is grown, method of harvesting and handling to the mill and grinding. In some places there is still only 95 per cent of the sugar recovered from the cane whereas in the most modern plants 98 to 99 per cent of sugar is recovered and in these cases the cane is very finely ground.

[1] Dr. Hugo Ashfeld, *Sugar Reference Book and Directory* (1940).
[2] Dr. O. W. Willcox, *Sugar Reference Book and Directory* (1940).

The mills range in size from the small ones grinding 100 tons in twenty-four hours to those grinding 1000 tons or 2000 tons in this period, and a few are still larger. A 2000-ton mill requires 100,000 to 150,000 lb of steam per hour and the mills generally work for twenty-four hours per day, seven days per week for the grinding season. This season lasts until the quota is ground, which may take three to four months. In some countries the labor laws provide for the employees to be hired by the year, and in such cases the mills may operate throughout the year except when the cane is in blossom. A few mills throughout the world operate 365 days per year. However, equipment must be periodically inspected and cleaned. Boiler equipment usually has a maintenance schedule as follows:

Primary furnaces each eight hours
Soot blowers each eight hours
Secondary furnaces every week

The operators of most sugar mills now understand that sugar must be kept out of the boiler water and that this water must be properly treated to remove scale-forming

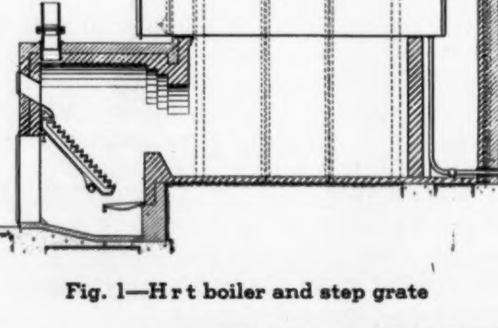


Fig. 1—H r t boiler and step grate

matter so that the boiler need not be shut down each month for turbining the tubes as was, at one time, the case.

Bagasse was originally burned on hand grates under horizontal return-tubular boilers. A sugar mill uses steam for power, for operating evaporators, etc., and the operators may open several valves at once, calling for the boiler to suddenly deliver as much as 50 per cent additional steam. The h r t boiler with its large water-storage capacity was ideal for this purpose and many sugar mill engineers still favor this type of boiler in batteries of ten to twenty. Some 350-hp h r t boilers installed at sugar mills in 1918 are still doing yeomen service.

Fig. 1 shows an h r t boiler with inclined grates. These are favored in Hawaii, Mexico and Venezuela. Many such jobs operate with natural draft.

Fig. 2 represents a standard flat grate. There is much silica picked up with the bagasse, and in burning, a glass-like substance is formed from the silica which tends to close the air spaces in the grates.

Fig. 3 shows the horseshoe, hearth or Cooke furnace. Here the bagasse piles up like a haymow and burns from the outside of the pile. The air for combustion enters through tuyères in the side-walls. Forced draft is necessary and it will be noted the horseshoe shape makes it easy to clean the hearth with pokers from the door at the front of the furnace. It is generally necessary to clean these hearths every eight hours.

In the Argentine some installations are being tried with the furnace bottoms on wheels so they may be removed from the furnace for ease in cleaning. Some natural-draft chain-grate stokers were at one time so arranged in the United States but have long since passed into the discard.

On many of the later furnaces rectangular instead of horseshoe shapes are being used. Hearths 5 ft 6 in. in diameter and 7 ft long are used but these larger hearths operate better by using a vertical air tube at the center of the pile to supplement the air coming in around the outside of the furnace. Large boilers, therefore, require

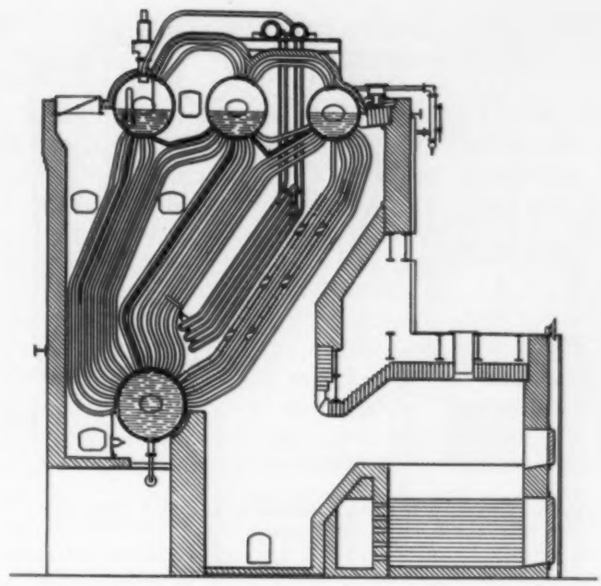


Fig. 4—Setting with furnace well under boiler

several furnaces and mill operators, unless they have a surplus of boiler capacity, prefer at least three furnaces on boilers of 500 hp and larger so that too much capacity will not be lost when a furnace is out for cleaning.

It was early found that better results were obtained by using an oven in front of the boiler. This makes it easy to feed the fuel to the furnaces as a conveyor takes the bagasse directly from the mills to the boilers. On some of the latest installations where high furnaces are used the bagasse is fed through chutes in the front wall.

Bagasse feeders are now the general rule, arranged with rotary cylinders or weighted doors so that air is admitted only through the proper openings.

As larger boilers were employed the sectional-header straight-tube and multi-drum bent-tube types came into use and today the demand seems to favor the bent-tube boiler. Its water-storage capacity is greater and its response to changes in load is more rapid than straight-tube boilers.

There have been two methods of setting the furnace in respect to the boiler, each of which has its advocates. Fig. 4 shows the furnace set well under the boiler. The advocates of this type of setting claim that refractory helps the burning of the fuel and that putting the front wall underneath the first bank of tubes and parallel to them increases the absorption in the first pass of the boiler by increasing the velocity of the gases over the tubes. The setting requires less brick and is therefore cheaper. When air preheaters have been added to these installations it has been necessary to hold boiler ratings to about 175 per cent to prevent slagging in the secondary chamber.

Fig. 5 shows the furnace moved forward to give a large secondary chamber on the theory that carbon and oxygen must be given time to unite for complete combustion and that the front bank of boiler tubes by being exposed to the ashes in the secondary chamber will reduce their temperature below the slagging temperature. The installation shown in Fig. 5 has operated at 200 per cent rating without slagging and with a minimum of char (unburned bagasse) carried from the stack.

Fig. 6 represents a typical step grate with a straight-

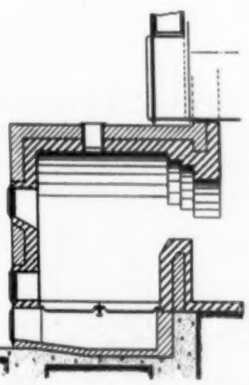


Fig. 2—Flat grate for h r t boiler

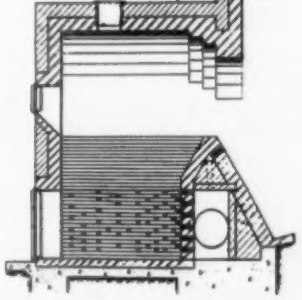


Fig. 3—Horseshoe or Cooke furnace for h r t boiler

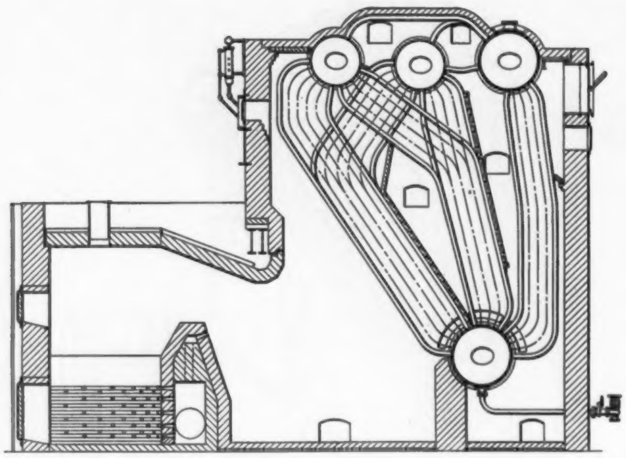


Fig. 5—Furnace moved forward to provide secondary chamber

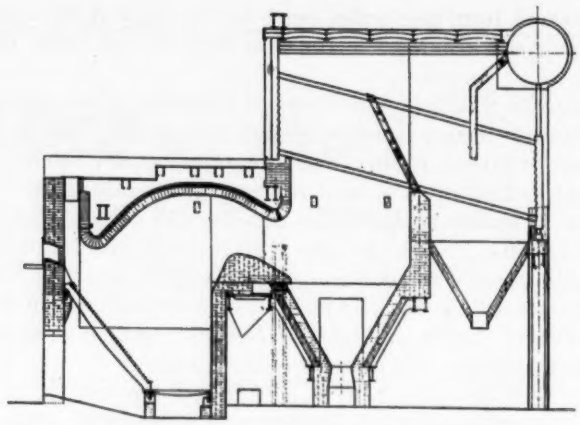


Fig. 7—Secondary furnace with automatic ash removal

tube boiler as used in Hawaii, Mexico and some other places. The Cooke furnace requires forced-draft to introduce the air through the tuyères into the furnace while the step grate is often used without any forced-draft blower.

On the larger furnaces some method must be used to cool the top of the arch. Usually a separate fan is installed for this purpose and the hot air is blown into the primary furnace or above the arch in the secondary furnace.

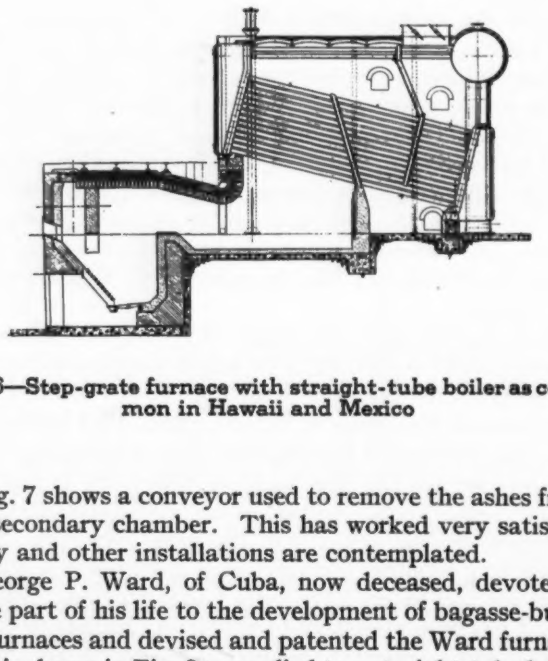


Fig. 6—Step-grate furnace with straight-tube boiler as common in Hawaii and Mexico

Fig. 7 shows a conveyor used to remove the ashes from the secondary chamber. This has worked very satisfactorily and other installations are contemplated.

George P. Ward, of Cuba, now deceased, devoted a large part of his life to the development of bagasse-burning furnaces and devised and patented the Ward furnace. This is shown in Fig. 8 as applied to a straight-tube boiler and in Fig. 9 to a bent-tube boiler. This was a big step in advance. It demonstrated that the bagasse would burn even if the fire were exposed to the black tube surface of the boiler. The early installations, however, left too little space between arches and the slag gathered on top of the arch, ran down and plugged the gas opening so that it was necessary to increase this opening and in many cases to remove one of the arches. One of the essential features of this arrangement is to keep the secondary combustion chamber less in volume than the primary chamber. This resulted in secondary combustion in the boiler and superheater zone and in many cases it has necessitated removal of a large percentage of the superheater surface. It has also caused a large carbon loss due to unburned bagasse, but many of the modern installations would never have been made had it not been for the pioneering of Mr. Ward.

For many years attempts were made to interest operators in economizers and later air preheaters but they showed no interest because they looked upon the bagasse as a nuisance and considered the easiest way to dispose of it was to burn it under the boilers. Finally it was demonstrated to them that production could be maintained at a higher point by economizers and/or air preheaters than without them because the steam pressure in the mill did not drop so far nor take so long to return to normal when the mill made sudden additional steam demands. By maintaining production the mill could cut several days from the operating schedule which meant real money. One mill in the Argentine uses both an economizer and an air preheater with each boiler.[3]

Bagasse contains 45 to 55 per cent moisture and the introduction of preheated air improves combustion materially. Those who have used air preheaters with bagasse state they will hereafter use preheated air on all jobs. Table 2 shows a comparison of some typical installations.

With preheated air 450 lb of bagasse per sq ft of hearth is satisfactory. The Hawaiian installation is included to indicate how much greater furnace width is necessary with a step grate and natural draft. The efficiency of

[3] COMBUSTION, January 1941.

TABLE 2—COMPARISON OF SOME TYPICAL INSTALLATIONS

	Lb of Bagasse per Sq Ft of Hearth	Country	Year	Heating Surface Boiler	Air Heater	Econ.	Total	Lb of Steam per Hr	Furnace width, Ft	Lb of Steam per Ft of Fur. Width	Type of Furnace
1	187	Hawaii	1926	4,780	...	..	4,780	22,500	11	2000	Step
2	428	Porto Rico	1939	9,996	4400	..	14,396	68,000	14	4850	Ward
3	386	Porto Rico	1940	10,500	4975	..	15,475	68,000	16	4250	Hearth
4	505	Argentina	1939	12,774	8000	10,000	32,774	90,000	16	5650	Hearth
5	375	Porto Rico	1940	12,500	...	..	12,500	68,000	19	3600	Hearth

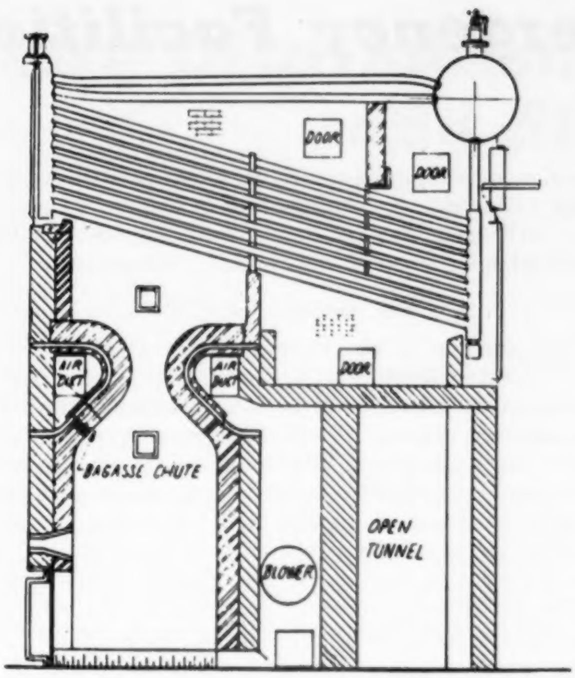


Fig. 8—Ward furnace with straight-tube boiler

this installation is approximately the same as the one in Argentine but it would take forty-four feet of furnace instead of sixteen to give the capacity that is obtained from the latter.

The three Porto Rican installations are very interesting. No. 5 employs natural draft for the boiler with forced draft on the furnace and cost the same installed with setting and all equipment as Nos. 2 or 3. It was designed for 54,000 lb of steam per hour but during its first season produced 68,000 lb of steam without difficulty. Induced-draft fans on bagasse jobs have given some difficulty in Porto Rico and similar troubles are reported from Natal, Africa, where many air heaters are used. In Natal the troubles are attributed to corrosion, whereas in Porto Rico they are thought to be due to erosion. A study of this problem is under way and an answer expected in the near future. If it is corrosion higher gas temperatures from the preheaters must be attained, and

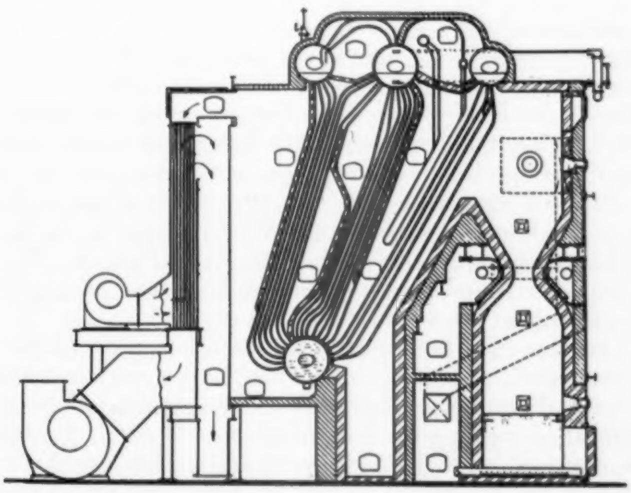


Fig. 9—Ward furnace with bent-tube boiler

if it is erosion slower speed fans and possibly straight, easily replaceable blades, as in the cement industry, may provide the solution.

What will be the future bagasse furnace? The writer believes it will be similar to that shown in Fig. 10 with fully water-cooled walls and the fuel blown into the furnace after having its moisture content reduced to 20 per cent or less by passing through a high-speed revolving dryer in which hot air is introduced. The bagasse will then burn in suspension like shavings. By removing some of the moisture, the boiler draft loss will be reduced and the present chimneys will allow these boilers to be operated at higher ratings. Samples of bagasse from one of the modern mills where 99 per cent of the syrup had been removed from the cane, which meant that the bagasse had been ground so fine it resembled shavings, were sent to the United States and worked very well with the arrangement shown. In some cases bagasse has value for making paper or indirectly in munitions work, which value is greater than that for fuel, but this applies only where the industry making such use of the bagasse is near to the source of supply, as transportation costs rapidly destroy this value.

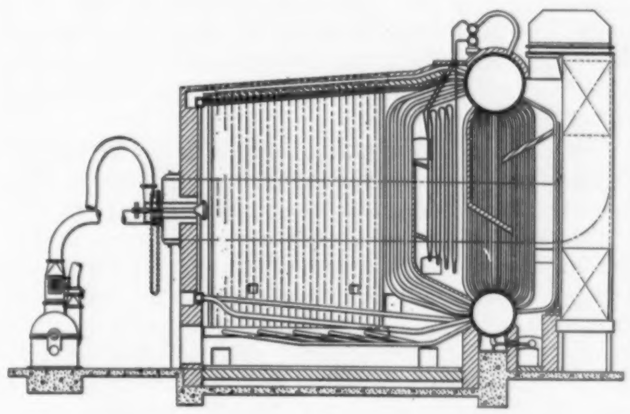


Fig. 10—Two-drum boiler and impact mill

Fuel per Kilowatt-Hour Reaches New Low

The coal rate by utility plants in the United States averaged 1.35 lb per kwhr during 1940, according to a report just released by the Federal Power Commission. This is the lowest rate ever recorded and compares with 1.39 lb per kwhr for 1939. It was due in part to the higher efficiency of new plants placed in service and in part to higher plant factors resulting from increased demand for electric power for defense production.

During 1940 electric generating plants consumed 53,398,131 tons of coal, 16,771,809 bbl of oil and 183,157,400 mcf of gas. Compared with 1939, the consumption of coal increased 15.5 per cent while the oil and gas consumption fell off 3.7 and 4.2 per cent, respectively. In other words, the amount of energy generated by coal totaled 79,229,168,000 kwhr in 1940 which was 12,592,159,000 kwhr more than were produced by this fuel during the previous year.

Amortization of Emergency Facilities

Addressing the National Association of Railroad and Utilities Commissioners at St. Paul, Minn., on August 26, Basil Manley of the Federal Power Commission outlined the policy of the Government with reference to depreciation of utility equipment to be added to meet the demands of the present emergency. His remarks were in part substantially as follows:

It would seem to be clear that investments in facilities which have a useful life limited to the emergency period should be amortized during that period. But it is equally clear that most of the extensions of plant facilities during the emergency period will not fall in this category. With rare exceptions new generating plants, substations and transmission lines will have a useful life extending for many years beyond the emergency period. We may anticipate that such facilities will be used to capacity, or even beyond that point, during the emergency and that, when the emergency ends, there may well be a considerable period during which there may be a decrease in the intensity of their use. The public interest, it would seem, would not justify any attempt to amortize completely during the emergency the investment in such facilities which will have a continuing use after the emergency is ended.

The problem is essentially one of depreciation. We recognize today that all investments in plant facilities must be charged off during their respective service lives. If the useful life of a facility is limited to the emergency, the full cost should of course be charged off during that period. If the useful life extends beyond the emergency, an estimate of the full service life must necessarily be made. Where it is anticipated that capacity operation will be followed by a period of slackened operation, there may well be justification for charging a higher rate of depreciation during the time of greatest production and lowering the rate when the slack period comes.

The answer to this problem may perhaps lie in giving some recognition to the so-called "production method" of computing depreciation expense which relates the rate of depreciation to the intensity of operations of the facilities. Some of the utilities, for example, are now overloading their generating facilities and all of them may have occasion to do so over considerable periods during the continuance of the emergency. We all know that such overloads increase depreciation and consequently it would be sound and reasonable to charge higher rates of depreciation during the emergency and lower the rates during any slack period that may follow the emergency.

The setting aside of larger amounts for depreciation during the period when facilities are loaded to capacity would also have a very desirable effect upon the financial condition of the utilities. While the majority of them now appear to be charging reasonably adequate depreciation, as a result of the activities of the State and Federal regulatory commissions, it is no secret that many of them did not make adequate charges in the past and, as a result, now have inadequate depreciation reserves. An increase in such reserves during the period of capacity operations will, of course, increase the financial stability of such companies. It is difficult to imagine a better use of increased profits resulting from capacity operations than to increase inadequate depreciation reserves. It may well be an anchor to windward against whatever financial and industrial storms that hereafter arise.

The Niagara Falls Case

The attitude of the Federal Power Commission toward the problems here under discussion can best be illustrated by a concrete case arising in connection with the national defense. Late this spring it became clear that a large amount of additional electric energy would be necessary to supply power to electro-chemical, electrometallurgical and other essential defense industries in the Buffalo-Niagara Falls area of New York State. It was also evident that such power could best be secured by the additional diversion of water from Niagara Falls through the existing facilities of the Niagara Falls Power Company which are now operated under a license of the Federal Power Commission. The Federal Power Commission therefore recommended, with the concurrence of the National Advisory Defense Committee, that the Department of State negotiate an agreement with Canada permitting the additional diversion of 5000 cfs during the emergency from the Niagara River. This was effected by an exchange of notes approved by the Senate on June 12, 1941.

Immediately thereafter temporary authorization to use this water was granted to the Niagara Falls Power Company conditioned upon the acceptance by the company of a license containing the necessary provisions to protect the public interest and prevent the enjoyment by the company of excess profits from the emergency diversion. The latter condition was necessary because it was possible for the company to utilize this water with little additional expense through existing facilities which were not operating to capacity. The sale of the power thus generated under current rates would have produced additional net profits in excess of $1,000,000 a year.

The company signified its acceptance of these conditions and, as a result, it is agreed that, after deducting its out-of-pocket expenses, including New York State fees and taxes incident to the diversion, and providing for the amortization during the emergency period of the relatively small capital expenditures necessary to utilize the diversion, with a 6 per cent return on the net amount of such capital expenditures, the balance of the revenues shall be applied to reducing the net investment in the Niagara Falls project. This net investment constitutes the rate base under the terms of the Federal Power Act. This reduction in the net investment will also be effective if the United States should recapture the project for public use at the end of the license period.

In this case the Commission would appear to have established, with the concurrence of the company, two essential principles: first, that there should be no excess profits in meeting the requirements of national defense; and second, that the investment in facilities useful only during the emergency should be amortized during that period.

Size Distribution in Pulverized Fuel and Stack Dusts

By H. L. OLIN, A. A. SMITH and G. L. SHAW

State University of Iowa

With the aid of a pneumatic classifier the authors conducted studies of samples in the minus 200-mesh range. These were taken at the university power plant and at three large utility power plants and included dust collected by a cinder trap, a multicyclone and an electrostatic arrestor. The tables show the size classification and ash content of the pulverized coal dust for each case studied.

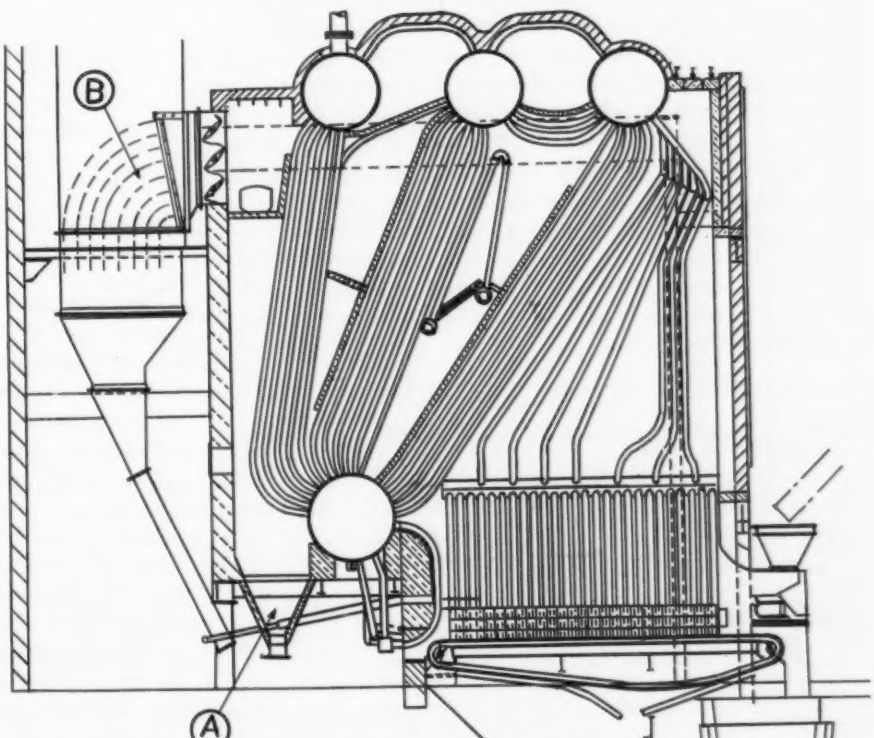
LOCATION of power plants near densely populated areas has added to the fundamental problem of fuel preparation the no less serious one of fly-ash disposal. The size of the coal particle as it enters the furnace bears a definite relation to pulverizer performance and combustion economies, and the size of the ash particle determines its chance of being arrested before leaving the stack or its radius of travel if it finally escapes.

Numerous investigations of dusts and dust-measuring techniques have been reported in technical literature but many have been limited to the use of standard screens in which the minus 200 fraction is lumped into a single class and only imperfectly classified in size range. Andrews (1) showed clearly by means of photomicrographs of different samples of minus 200 pulverized coals the wide range in particle size in this fraction. He concluded that "this study shows that the standard 100-mesh and 200-mesh percentage method of testing pulverized coal is at fault in that it is not complete enough to show the actual pulverizing work done and that it may actually be misleading in a comparison of two samples." It may be inferred that his criticism applies, therefore, to the limitations of A.S.T.M. Designation D 197-30, inasmuch as the standard method makes no provision for classification beyond 200 mesh.

In his studies of the grinding effectiveness of different mill types, Work (5) stresses the importance of the fineness of the sub-sample. He states: "The superfine particles which may be considered 0.2 or 0.1 mesh, well mixed with air, make the reaction approach more nearly to one of true gases and make the flame self-sustaining." In estimating size distribution in the minus 200 fraction he prepared uniform dust slides and projected them through the microscope to a screen. All particles in each field were measured with a scale and assigned to their respective size intervals. On the assumption that the particles of all sizes were statistically similar and of the average diameter of the interval, the number of particles falling in each interval was calculated to the weight basis.

Hardie (3), of the Research Bureau of the Brooklyn Edison Company, described an elaborate system for quantitative dust sampling that may well serve as a model for investigations of this kind. Ultimate size classification was limited to "on and through" 325 mesh.

The importance of dust studies in the range below



Section through setting indicating sampling points

200 mesh, bearing as they do on both grinding economies and fly-ash problems, coupled with the meagerness of published data, prompts us to report the results obtained with the aid of an air classifier on typical pulverized coals and flue dusts. The work was originally undertaken to measure the qualitative effectiveness of dust traps installed in the flue system of the university power plant, located near the center of the campus and designed to minimize potential dust nuisance. The results are presented with only brief comment in the hope that plant engineers may find them interesting and useful.

In our work the classification of the fine dusts was simplified by the use of a Federal Laboratory classifying unit (2) with which the fraction of 74 microns and under (minus 200 mesh) was separated into a number of subfractions rather sharply defined within narrow ranges of diameter. It followed, therefore, that the necessary microscopic examination (made with a Zeiss microscope and a Bausch & Lomb ocular micrometer) was limited to the estimation of minimum, average and maximum grain particle size, percentages by weight of the subfraction having already been obtained in the mechanical fractionation. It should be observed that examination of duplicate slides from a given fraction showed that although particles differed in shape there was remarkable uniformity in range of size.

Dust Studies at the University of Iowa Power Plant

Dust studies at the university plant were centered on two units equipped with 600-hp 4-drum Stirling boilers and Detroit Roto-Grate stokers. Special interest attaches to the latter because combustion takes place, to some extent at least, while the coal is suspended in the furnace gases under conditions more or less conducive to dust movement. Samples were collected at three points (see sketch), namely, from the collector *A* located below the last pass just beyond the lower drum; from the cinder trap (*B*) located, for reasons of space limitations, in the breeching; and at the base of the stack. In addition the minus 200 fraction from the coal as fired was tested with the other dusts. Table 1 is a summary of results of the analysis.

TABLE 1—ANALYSES OF DUSTS FROM UNIVERSITY OF IOWA POWER PLANT

	Coal As Fired (Mahaska Co., Iowa Crushed; 11.2% Ash)	Collector Bin	Cinder Trap	Stack Base
	Screen Separation (Percentages of Gross Sample)			
Mesh				
0–12	82.35	0.13	0.10	0.17
12–20	7.05	7.51	0.69	0.57
20–30	2.35	14.45	3.36	3.45
30–40	1.88	13.02	9.25	8.30
40–100	1.91	36.50	37.40	40.60
100–200	1.44	21.02	32.60	28.09
Minus 200	3.60	7.41	16.70	18.80
	Pneumatic Separation of Minus 200 (Percentage Weight of Gross Sample)			
Micron Size (μ)				
40–75	1.81	3.33	11.42	12.08
15–40	1.52	2.02	3.17	4.29
8–15	0.014	1.02	0.82	1.03
1–8		0.08	0.51	0.20
0–1	0.2	0.32	0.48	0.33
Loss		0.62	0.30	0.87

No means were available for taking samples of dust from the top of the stack and no material balance can be made up from the data gathered, i.e., the figures present a qualitative picture only. It was observed, however, that the amount collected in the cinder trap was approximately two-thirds of that obtained in the collector. It is apparent from the figures shown that the collector performed the heavy work on sizes above 40 mesh. It is clear also that the cinder trap and stack base dusts were similar throughout the entire range of sizes, indicating that the trap was below the capacity required for doing all the work for which it was adapted and that the stack sump is supplementary rather than complementary to the trap. Below 40μ percentages drop sharply and it may be concluded that, in the main, the dusts floating into the atmosphere range downward from that size. It is the practice in this plant to blow the collector and trap dusts into the furnace for reburning and recovery of fuel values of 33.3 and 24.0 per cent carbon, respectively. The stack base dust with 23.3 per cent carbon is wasted.

Electrically Precipitated Fly Ash

Through the courtesy of the Northern Indiana Public Service Company of Michigan City, Indiana, a sample of Cottrell-collected dust from its large pulverized coal plant was made available for study. The relatively large percentage of extreme fines removed (15 per cent below 4μ) indicates the special care evidently taken by the company to safeguard the interests of not only the residents of the city but of its large summer tourist population. Results of the dust analysis are shown in Table 2.

TABLE 2—COTTRELL STACK DUST

Mesh	Micron Diameter	Percentage
	Screen Separation	
0–80	175+	0.16
80–100	144–175	0.48
100–200	74–144	3.73
200-	0–74	95.64

Pneumatic Separation of Minus 200

Micron Diameter	Percentage (Gross Sample)
38–75	3.71
18–38	16.48
8–18	23.15
3–8	29.30
1–4	7.82
0–2	7.33
Loss	9.01

In continuing our survey of power plant dusts we obtained some typical pulverized coal and fly-ash samples from the new plant of the Iowa Electric Light and Power Company at Cedar Rapids. Coal grinding equipment consists of four B & W Fuller-Lehigh type mills; dust is arrested by means of a centrifugal type collector and a multicyclone, both made by the American Blower Corporation.

Bins 1 and 2 from which the samples of fly ash were taken are arranged in parallel and receive similar dusts from the centrifugal collector. It may be seen from Table 3 that the agreement in size distribution to be expected is attained in all fractions except the 45–74 micron. Whether some segregation takes place has not been determined. At any rate, below 20 microns weight percentages fall away sharply and it may be concluded that below this size the separator is not highly effective.

Similar tests of the pulverized coals fired in this plant are reported in Table 4, together with ash contents corresponding to size variation. A marked drop in ash percentage is noted in this range between 20 and 45 microns (see also Table 5)—a fact also observed by Raszak (4) in his determinations of ash and volatile

matter of graded fractions. In the absence of any rational explanation the matter must rest for the present.

TABLE 3—CLASSIFICATION OF FLY ASH FROM CENTRIFUGAL COLLECTOR

SCREEN SEPARATION

Mesh Size	Micron (μ)	Percentages: Bin No. 1	Percentages: Bin No. 2
0–100	144+	3.1	1.5
100–200	74–144	19.9	19.0
200–	0–74	77.0	79.5

PNEUMATIC SEPARATION OF MINUS 200

Micron Size		Percentage Weight of Gross Sample	
45–74		17.2	33.3
22–45		50.0	40.5
9–22		3.2	2.9
3–9		1.4	1.2
0–3		1.3	0.5
	Loss	3.9	1.1

TABLE 4—SIZE CLASSIFICATION AND ASH CONTENTS OF PULVERIZED COAL DUSTS

SCREEN SEPARATION

Mesh Size	Microns (μ)	Percentages: Mill No. 3 Weight	Mill No. 3 Ash (Dry)	Mill No. 4 Weight	Mill No. 4 Ash (Dry)
0–100	144+	5.0	6.43	1.6	6.12
100–200	74–144	31.6	8.89	18.2	9.21
200–	0–74	63.4		80.2	

PNEUMATIC SEPARATION OF MINUS 200

		Percentage Weight of Gross Sample			
	45–74	4.2	14.80	4.1	15.68
	22–45	33.9	9.40	45.7	9.25
	9–22	10.7	11.16	11.5	10.18
	3–9	8.9	14.33	10.6	15.13
	0–3	1.5		2.4	
	Loss	4.4		5.9	
Ash content of original coals			10.00		10.63

TABLE 5—SIZE CLASSIFICATION AND ASH CONTENT OF PULVERIZED COAL DUST AT DES MOINES ELECTRIC LIGHT COMPANY

SCREEN SEPARATION

Mesh Size	Microns (μ)	Percentage (Gross Sample) Weight (Dry)	Percentage (Gross Sample) Ash Content (Dry)
80+	177+	2.7	
100–80	144–177	3.1	12.85
200–100	74–144	13.8	13.87
200–	0–74	80.4	

PNEUMATIC SEPARATION OF MINUS 200

Micron Size	Percentage (Gross Sample) Weight	Percentage (Gross Sample) Ash Content
74–48	8.7	17.01
48–18	34.2	15.31
18–6	20.2	16.45
6–1.5	12.1	18.44
1.5–	4.0	

Ash content of original coal, 16.17 per cent

This series of tests was concluded with a study of pulverized coal used at the new plant of the Des Moines Electric Light Company. Especially interesting is the high percentage of extreme fines, nearly 40 per cent below 18 microns, with ash contents distinctly higher than that of the original coal. A study of the effect of such grinding on the slagging tendencies of the low fusing coal ashes of Iowa and other midwestern states might bring out important facts in overcoming bad tube conditions.

Granting the importance of dust measurement in the study of power plant problems involving material and energy balances the advantage gained in simplification of the technique involved is obvious. We have found the pneumatic classifier of immense value in our studies, not only in reducing the time required for a test run but in greatly increasing the accuracy of the result.

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Determining Coal Characteristics

At the meeting of the American Chemical Society in Atlantic City, September 8 to 12, the Division of Gas and Fuel Chemistry sponsored several papers dealing with determinations of coal characteristics.

J. A. Taylor, of Pennsylvania State College, described a method of ascertaining ash-softening and flow temperatures in which only small amounts of ash, one milligram or less, are involved. This consists in making small ash cylinders with a capillary glass tube as a mold and a thin glass or steel rod as a plunger. These cylinders are then mounted on a small piece of firebrick partly covered with alundum cement and heated in a small gas-fired porous muffle furnace at the rate of 25 to 50 deg F per minute. The cylinders are observed, through a port in the furnace, with a microscope which is in a fixed position several feet away. The temperature at which the cylinder forms a sphere is designated as the "micro-softening temperature" and that at which the sphere flows out over or into the plaque is the "micro-flow temperature." The average error for the micro-softening temperature, with 25 determinations, was plus or minus 19 deg F and the average error for the micro-flow temperature was plus or minus 37 deg F. The flow temperature was in most cases more difficult to determine than the softening temperature.

Volumetric Determination of Sulphur

In the present standard A.S.T.M. method, sulphur in coal and coke is determined gravimetrically as barium sulphate, the sulphur in the sample being converted into soluble sulphate by combustion in an oxygen bomb or by fusion with sodium peroxide or Eschka mixture. A volumetric method was reported by S. S. Tomkins, of the Consolidated Edison Company of New York, summarizing the results obtained by eight cooperating fuel laboratories on four samples of coal containing 0.7, 1.0, 2.0 and 3.0 per cent by weight of sulphur. Both the A.S.T.M. method and two volumetric methods using tetrahydroxyquinone (T.H.Q.) and sodium rhodizonate, respectively, as internal indicators. A total of 392 determinations was made and the test data indicated that either the gravimetric or the volumetric method for determining sulphur in coal would give equally satisfactory results, although when time is important the latter is preferable.

Coals High in Calcite and Pyrite

O. W. Rees, of the Illinois State Geological Survey, and **W. A. Selvig,** of the U. S. Bureau of Mines, reported on "The Determination of Ash in Coals Unusually High in Calcite and Pyrite." With such coals difficulty is sometimes experienced when employing the standard A.S.T.M. procedure, due to varying amounts of sulphur being retained as calcium sulphate in the ash. Therefore, various procedures involving different rates of heating were tried at the laboratories of the Bureau of Mines and the Illinois State Geological Survey and the results compared with those obtained when using the Parr sulphated ash method. In general, it was found that starting with a well-ventilated, cold muffle furnace and heating slowly so that a temperature of 750 C was reached in not less than 90 to 105 minutes gave satisfactory ash results for samples commonly encountered in commercial work.


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OUTSTANDING in its many unique features is the water softening system in the modernized boiler plant of the Froedtert Grain & Malting Company, Inc., at Milwaukee, Wis. Effluent from the Cochrane twin Sodium Zeolite units is blended to the proper alkalinity with that from the twin Hydrogen Zeolite units, and then passed to the Cochrane Decarbonator for removal of dissolved CO_2. After being mixed with condensate filtered through Cochrane Oil Removal Filters, the final feedwater is assured "zero oxygen" by means of a Cochrane Deaerator.
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COMBUSTION ANALYSIS

Abstract of a paper[1] by H. B. Lammers[2] and E. B. Woodruff[3] which was awarded the Second James H. McGraw Prize for 1941. The authors show (1) that spot sampling is unreliable as a guide for combustion control where accuracy is desired in maintaining fuel-air ratios and eliminating smoke; (2) that oxygen recorders operating from spot samples are usually inaccurate for indicating combustion conditions, because of too much time lag when boilers are operating with fluctuating loads; (3) that stratification exists and varies with burner combinations; and (4) that the only accurate method of securing a true analysis is by making a traverse across the width of the boiler and employing high-speed charts.

REGARDLESS of the particular equipment and physical procedure, there are but four factors which influence combustion:

(1) The air supply must be sufficient to provide the required oxygen.

(2) The fuel and air must be thoroughly mixed.

(3) The duration of time that the mixture of fuel and air are held at the elevated temperature.

(4) The temperature of the fuel and air during and after mixing with the fuel.

All combustion equipment attempts to control these four physical factors. It follows that all combustion processes may be analyzed with respect to the degree by which they meet these requirements.

While the theoretical amount of air required for a given fuel is easily calculated when the fuel analysis is known, the amount of air actually required for a given installation depends upon physical and economical limitations and is best determined by experiment. The boiler unit is operated at various loadings and percentages of excess air. Studies are made of the operating conditions, efficiencies and maintenance costs. The limiting factor in reducing the excess air may be:

(1) Excessive unburned fuel losses.

(2) High furnace maintenance owing to high furnace temperatures.

(3) Operating difficulties in form of tube slagging or clinker formation.

From this comprehensive study, the optimum percentage of excess air is determined. The percentage will vary when there is a change in the analysis of the fuel and certainly when there is a different type of fuel used. Then the optimum percentage of excess air will vary with the boiler rating. For example: With refractory walls the excess air is increased when the rating is increased. When water-wall units with slag-tap furnaces are employed the excess air may be decreased as the rating is increased. To proportion fuel and air when the load is steady and when it is fluctuating to fifty per cent of the boiler capacity every few minutes, is an entirely different story.

[1] Published in full in the *Edison Electric Institute Bulletin* for August 1941.
[2] Power Supervisor, Wright Aeronautical Corporation, Lockland, Ohio.
[3] Plant Engineer of the Columbia Power Station, Cincinnati Gas & Electric Company.

The second important factor in the combustion process is the mixing of air and fuel. There is a great difference between coal moving down through the retort of an underfeed stoker and a speck of coal moving in a pulverized fuel furnace. Other conditions remaining the same, combustion is improved by increasing the surface per unit of volume. An inch cube of coal has 6 sq in. of surface to come in contact with oxygen. When pulverized ready to burn, this cubic inch of coal would have approximately 500 sq in. of surface.

With this enormous surface exposed for oxidation the next step is to see that the air and small coal particles are thoroughly mixed. Present burners are a great improvement over those formerly used. The primary air and coal are thoroughly mixed and the secondary air is added at the point where the fuel enters the furnace. The turbulence assures mixing and a fairly uniform supply of oxygen to each particle of fuel. A less favorable condition prevails when the unit is operated at reduced rating with only part of the burners in service.

Time an Important Factor

Very closely related to the mixing of fuel and air is the time during which this mixture remains at high temperature. The advantage obtained by the enormous increase in surface area resulting from pulverizing coal is partly lost by the short duration of time that the coal remains in the furnace. In a high rating unit it may require but three-quarters of a second for the fuel to pass from the burner tip through the furnace to the convection surfaces. When one considers this short time in which combustion must be completed it is easy to see why air and fuel must be so accurately proportioned. This short combustion time is a disadvantage inherent in the modern high-heat-release units. However, this disadvantage is relative to other combustion conditions and its effect upon final results is minimized by proper air-fuel ratio, thorough mixing and high temperatures.

The other important factor is the temperature maintained during the combustion process. Well known is the fact that the fuel must be above some temperature known as the kindling point. There is a difference of opinion as to the effect of extremely high temperatures. When boilers equipped with water-cooled furnaces are

operated at low ratings the furnace temperature is low and the carbon loss in the fly ash is high. Combustion is retarded by the low temperatures resulting from heat absorption by the furnace walls. With this type of installation it is frequently necessary to increase the excess air as the rating is reduced in order to compensate for low temperature and poor mixing. From this we see that the four factors which influence combustion are interrelated. Furnace temperature is controlled either by changing the percentage of excess air or by adjusting the amount of heat-absorbing surface which receives radiant heat from the furnace.

From these considerations it is evident that the proportioning of air to fuel is an important factor in the combustion process. In modern boilers, low percentages of excess air and fluctuating loads increase the necessity for accurate regulation. Because of these requirements, present combustion instruments have certain shortcomings.

When the carbon dioxide analyzer is used to determine combustion conditions we are confronted with two difficulties. First is the question of locating the sampling tube so that the gas sample will be representative. This becomes a very serious problem when burners are taken in and out of service to regulate the boiler output. Then there is the time delay between the combustion process and the time the instrument records or indicates the results. The combustion of coal in a pulverized fuel furnace is a matter of seconds, so that the unit may produce smoke long before improper combustion conditions are indicated by the instrument. In addition to time lag, many carbon dioxide recorders do not indicate the maximum and minimum values but give an average which is not indicative of actual conditions. However, manufacturers of carbon dioxide recorders have been making progress in producing instruments with less time lag.

Another method of indicating combustion conditions is to compare the differential, caused by the flow of gases through a section of the boiler, to the steam flow from the boiler. In a given boiler the steam flow is proportioned to and may be used as a measure of the heat input. It has been proved that for a wide range in fuel analysis the air required is proportional to the heat content. The flow of gases can be measured by the differential draft drop across a section of a boiler in much the same manner as a flowmeter measures steam. It follows that the steam flow is a function of the fuel used, and the pressure drop across the boiler pass is a function of the air supplied to the unit. When properly calibrated this steam-air flow instrument may be used as a combustion guide. The calibration is such that when the steam-flow and air-flow indications coincide, optimum combustion conditions are obtained.

When the boiler output is changing rapidly, it is not desirable to have the steam-flow and air-flow indicators coincide. When the boiler output is increasing rapidly, fuel is being burned at a rate in excess of what would normally be required for the instantaneous output. When the air flow-steam flow relation is maintained under these conditions there will be a decrease in the percentage of excess air. In a similar manner if the load is decreasing and the air flow-steam flow relation is maintained, there will be an increase in the percentage of excess air. From this we see that when the load is changing, the air-flow indication must precede the steam.

Whether the boiler unit is regulated by hand or by automatic combustion control, the fundamental problem remains the same.

Flue Gas Analysis

In analyzing combustion conditions one is confronted with the following questions: What methods of procedure are available for analyzing combustion conditions? What instruments should be used? By what method and from what location should the analysis be secured?

The Orsat analyzer is usually employed where accuracy is desired. For continuous recording, carbon-dioxide and oxygen analyzers are often used.

Regardless of what type of instrument is used, testing with an Orsat is the usual method for checking the accuracy and is consequently relied on to a considerable extent. Extreme accuracy is possible with this instrument if it is used properly.

The sampling location for purposes of analysis is of the utmost importance. The analysis should be as complete as possible if accuracy is desired. However, the many conflicting points must be given serious consideration.

The sample must be secured or taken from a zone of high velocity gas and at a point where combustion is considered to be complete.

If the sampling location chosen is close to the furnace, combustion may not have been completed. High furnace temperatures make water-cooled sampling pipes necessary.

If the sampling location is in the boiler uptake, preheater, or suction to the fan, combustion should be complete and water-cooled sampling pipes will not be necessary. However, air leakage (infiltration) and the fact that the sampling point is far removed from the combustion process tend to make the sample less valuable.

Spot Sampling and Speed

When the boiler is of considerable width, a spot sample has little significance and is of very little practical value for maintaining fuel-air ratios. Many studies have been made in an effort to determine the locations considered suitable for securing average samples.

Assuming the location is found to be suitable, the next question is whether or not the analyzer is sufficiently fast to permit a thorough study of conditions prevalent in the modern furnace. When the analysis is made with an Orsat, at best, the sample is intermittent. When made with a carbon-dioxide recorder, the analysis is neither complete nor fast enough. A time lag of one to three minutes is normal. If the analyzer is at some distance removed from the point of sampling, as much as ten minutes time lag is frequently introduced.

Carbon-dioxide recorders may be considered a guide, but never as an index of combustion, even though the sampling location be considered satisfactory. Where accuracy is desired other methods of analysis must be employed.

Combustion conditions are studied for the purpose of eliminating difficulties in the equipment or control mechanism. This analysis can be made (1) at steady rating to determine the excess air and resulting conditions desired, and (2) with fluctuating loads, to analyze the performance with quick changes in load, eliminate

smoke, make the unit respond faster and improve the efficiency.

Where spot sampling is resorted to, the questions frequently asked are: "How accurate is the sample?" "How is the sample affected by stratification?"

Excess Air vs. Rating

The steam-air flowmeter is calibrated by making a traverse of the pass through which the gases pass at high velocity before they enter the convection surfaces. This procedure reduces the inaccuracy of spot sampling.

In a modern furnace employing automatic control, large quantities of fuel are burned in a given time; hence the time element is important where analysis is concerned. When changes in load are made almost instantaneously the fuel and air must be varied in correct proportions to approach perfect combustion. Hence, the importance of time cannot be over-emphasized if combustion conditions are to be properly synchronized with operating performance and correlated with the control equipment. In most cases the time allotted to combustion (before the gases enter the convection surfaces) is in the nature of three-quarters to two seconds.

For high-speed analysis, the procedure normally had been to use four or five Orsats.

If the problems confronting the combustion engineer are to be solved, the samples drawn must be sufficiently fast and continuous.

Procedure for Analyzing Combustion Conditions

How combustion conditions were analyzed in a modern high-rating boiler is explained somewhat in detail.

A location was selected at a point where the gases enter the convection pass. At this point combustion is considered to have been completed and air infiltration has no appreciable effect on the analysis. This location requires a water-cooled sampling pipe.

Sampling and analyzing the gas were accomplished by means of an oxygen analyzer and recorder. The feature of the analyzer is the speed with which the sample is secured as the time lag is only about five seconds.

A daily operating record of the steam-air flow and oxygen chart is shown in Fig. 1. It is apparent that the fluctuations shown by the oxygen recorder are entirely too rapid and the excess air (oxygen) is not very steady. As a matter of fact, these fluctuations are so rapid that they are not even reflected on a carbon dioxide recorder. It is apparent that variations in oxygen reflect disturbances in the furnace but that the movement of the pen on the chart is so rapid that it is difficult to determine the cause. It is evident that the combustion process is not proceeding as it should.

With the normal chart shown in Fig. 1 it is impossible to synchronize the operation of the control with the combustion process.

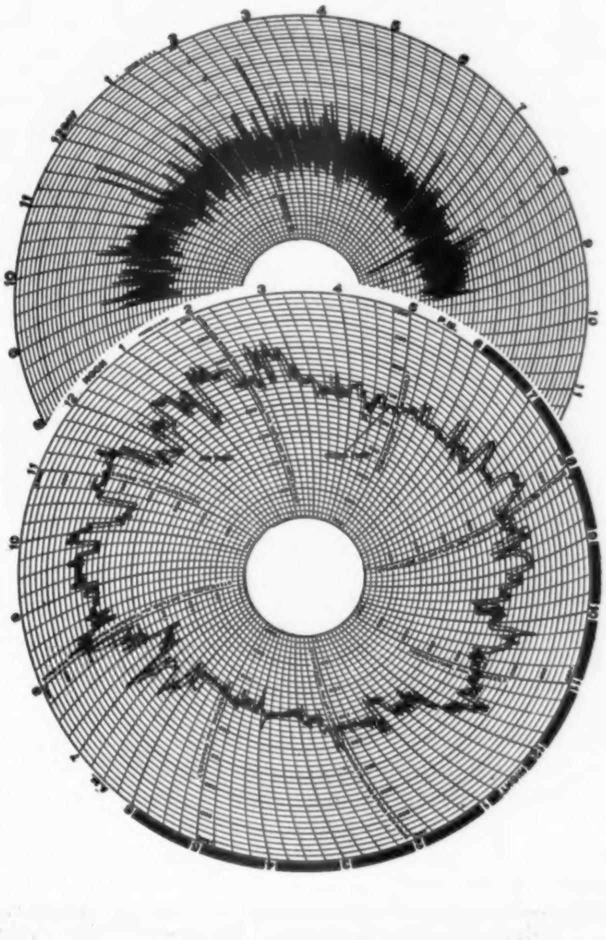


Fig. 1—Daily operation—comparison of steam flow-air flow and oxygen record

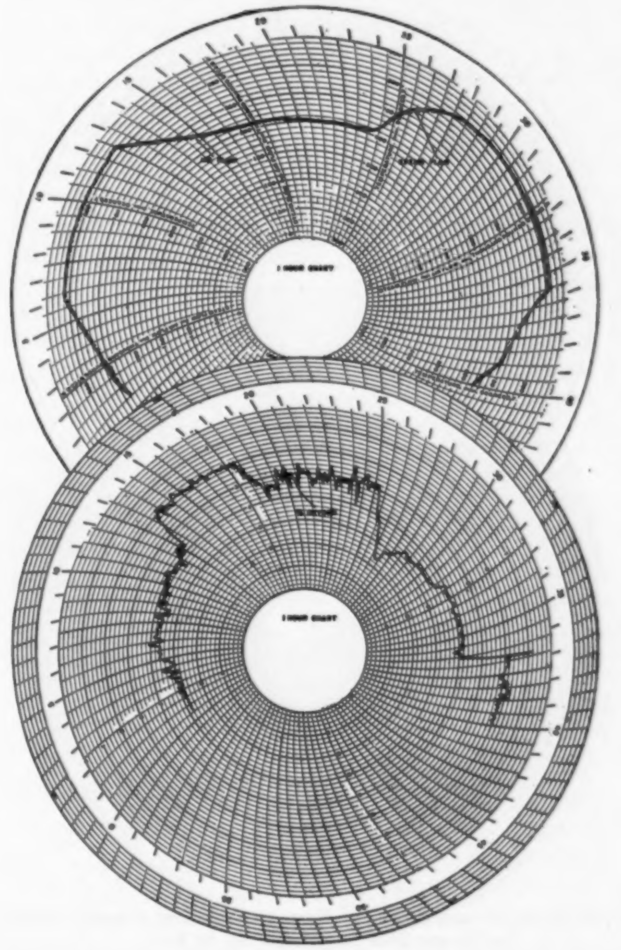


Fig. 2—Comparison of steam flow-air flow and oxygen record (air flow proportioned to steam flow)

In order better to study the combustion conditions a "fast" chart was installed on both steam and air flow-meters and the oxygen recorder. The speed of the chart is one revolution per hour which then magnifies the record twenty-four times.

Steam-Air Flow Proportioned

A comparison of the steam-air flow is shown in Fig. 2 together with the oxygen record with the air flow proportioned to the steam flow. By proportioning is meant that the combustion control equipment is so operated that the air-flow and steam-flow records coincide.

rapidly and the mill level is reduced and for a short period of time we have an excess of fuel (or a deficiency of air or oxygen). When the level is restored the excess air (oxygen) remains low until the definite loading point is reached.

In reality there exists a deficiency of air from the time the rating increase begins until the steam reaches its maximum.

Air and Fuel Proportioned

A comparison of the operation with the steam flow proportioned to fuel is shown in Fig. 3. The combustion

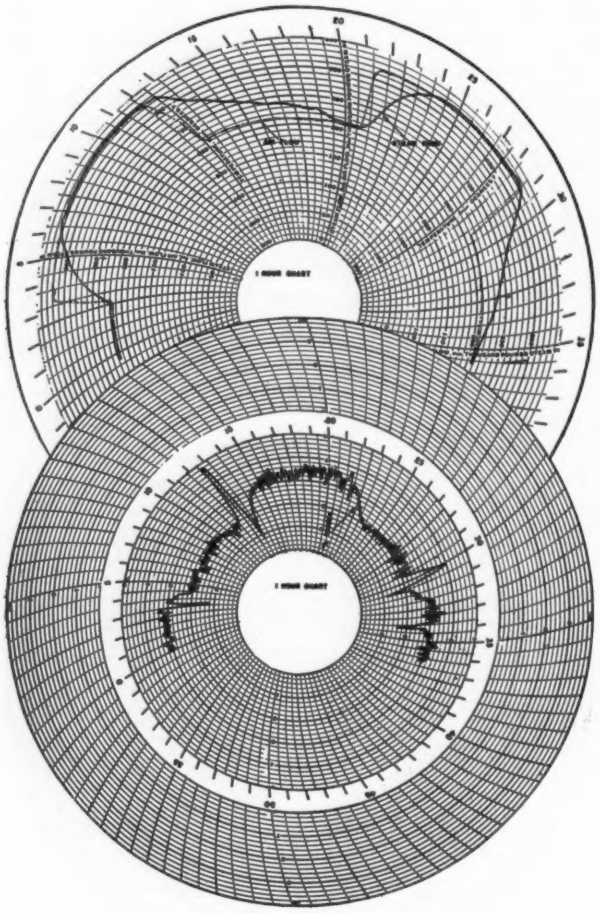


Fig. 3—Comparison of steam flow-air flow and oxygen record with air flow proportional to fuel

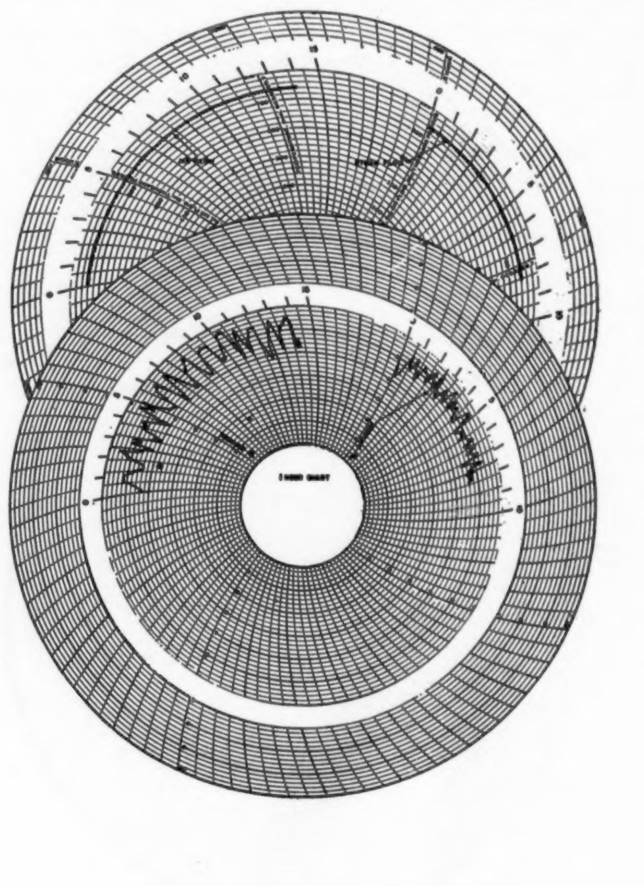


Fig. 4—Comparison of steam flow-air flow and oxygen record before and after shortening feeder-controller cycle

On these tests the changes in rating were effected by definitely positioning the fuel for some predetermined change. The time required to produce this change is shown on the fast chart and the change in oxygen content is noticeable. One can see what occurs when steam and air are proportioned and made to coincide during the change.

When the flow is reduced to 210,000 lb per hr, the oxygen content goes up due to the fact that more air is being supplied than is actually desired. Notice how, when the flow approaches 210,000 lb per hr, the oxygen (excess air) is gradually being restored to its proper value. This value is slightly higher than at the previous rating because the boiler meter is set to carry a variable excess air.

When the load is increased, the fuel is supplied very

control equipment is made to operate so that the air flow coincides with the fuel input.

By this is meant that when changes in rating are made, the air is not made to coincide with the steam flow except at time intervals when the fuel input is not being varied (steady rating).

Again the rating was changed by definitely positioning the fuel and air together and simultaneously in the correct proportions. Hence on a load increase, the air is made to position itself immediately for the desired steam-flow change.

The relationship between fuel and air can be carefully analyzed and comparison made with the performance in Fig. 2. This improvement is reflected on the oxygen chart record. On a pickup in load, the air flow precedes the

(*Continued on page 54*)

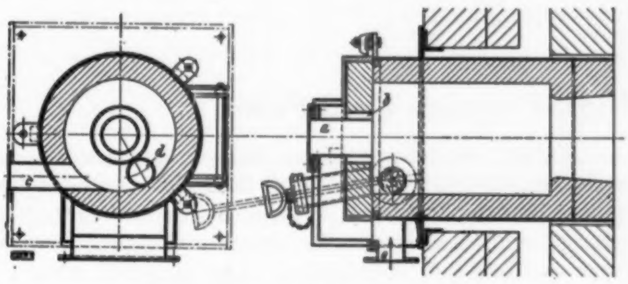
STEAM ENGINEERING ABROAD

As reported in the foreign technical press

Pulverized-Coal Ignition Device

In *Wärmewirtschaft und Dampfkesselwesen*, Vol. 21, p. 242, is described a pulverized-coal ignition device consisting of a cylindrical refractory muffle having an orifice-like exit and operating with two partial streams of pulverized coal (see sketch). The smaller of these is admitted into the muffle tangentially and the larger axially. Both are regulated and the required air under pressure is supplied by a fan common to several boilers.

When starting, the axially directed stream is temporarily shut off and the muffle is supplied by the tangential stream only. After ignition has been established by means of a torch, the walls of the muffle chamber warm



Section through muffle igniter

a. Axial coal stream port
b. Warm air admission to muffle
c. Tangential coal stream port
d. Ignition opening
e. Warm air inlet

up rapidly, whereupon the axial stream of pulverized coal is turned on. This leaves the muffle exit in a flame three to four meters long which is ample to light the main burners.

During very low ratings on the boilers the ignition muffle is run continuously so as to assure definite maintenance of ignition. The device is of small proportions and may be employed with vertical, horizontal or tangential forms of firing. Apparently it was devised to conserve oil as an ignition medium.

New Velox Design for Naval Use

The combined January-February-March 1941 issue of *The Brown-Boveri Review*, copies of which have just become available in this country, comments on recent developments of the Velox boiler for naval and merchant ships.

Heretofore, a disadvantage of this type of boiler for naval use has been that it had to be built for full load, although rarely called upon to deliver full output in actual service. While the full-load efficiency was high, that at partial loads, corresponding to cruising speeds, was considerably lower and the steam temperature also dropped.

Recent investigations, however, have shown that such boilers can be designed to reverse these conditions; that is, by designing for a certain overload with an efficiency of about 82 per cent, at half load the efficiency will be around 90 per cent, including all auxiliaries excepting the feed pumps. Furthermore, the steam temperature remains practically constant over a wide range in load.

A new design has been developed for warships having low boiler rooms. This is characterized by the superheater and the major part of the evaporating surface being taken out of the combustion chamber proper and lodged in horizontal housings, the combustion chamber being made only large enough to burn the necessary amount of fuel. The superheater and horizontal evaporating surface are lodged under the surface grating in parallel with the charging set, which determines the length of the plant, and the longer distance which the gas has to travel allows of increasing the gas section, which is advantageous. The feedwater heater is upright and has two sets of tubes, connected in series. All heating surfaces can be dismantled and the housing containing the superheater, evaporating surface and feedwater heater has removable covers extending the whole length.

The unit weight is somewhat lower than that of the standard design, a boiler of 145,000 lb per hr rated capacity weighing 0.85 lb per pound of steam produced per hour, including oil and water. As these boilers are narrower than the steam turbines they supply, both boiler and turbine can sometimes be placed side by side between the same bulkheads.

Stresses in Flanged Joints

Claiming that the usual calculations for the difference between the axial expansion of a flange at the sealing end and that of the bolts are insufficiently accurate, an article by Paul Kaehler in *Die Wärme*, Vol. 63, No. 47, analyzes means for minimizing the added stresses in the bolts. The discussion is predicated on the theory that

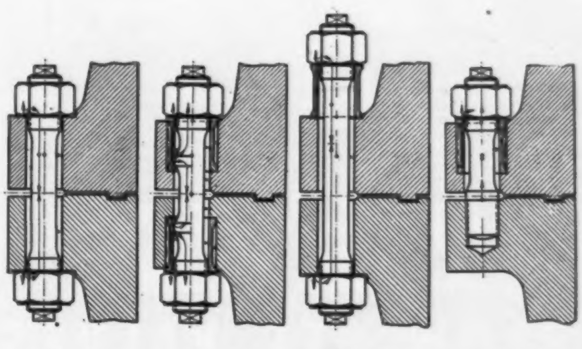


Fig. 1 Fig. 2 Fig. 3 Fig. 4

The four types of bolts discussed

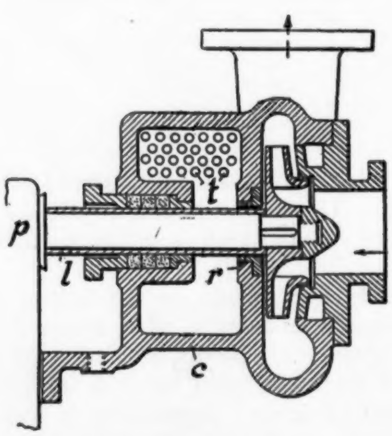
if a rectangular section of the flange be heated at the pipe end, the section will tend to assume a slightly trapezoidal form, with a radial temperature gradient, during the heating-up period. This deformation, it is claimed, introduces superimposed bending stresses into the bolts which receive their heat chiefly by conduction from the flange.

Four types of flange connections are shown and the conduction of heat with each is traced. Of these the usual type (Fig. 1) having through bolts with elongated shanks is stressed the most during the heating-up period. That which is stressed the least comprises through bolts having collars which are deeply recessed and a loose fit into the flange with contact with the bolt near the bottom of the recess. These collars serve as spacers between the bottom of the recesses and the nuts (see Fig. 2). The flow of heat from the flange to the collar, thence to the bolt is via the shortest route and this heats the bolt more quickly. The superimposed bending stresses, previously mentioned, are said to practically disappear when employing collars which may be made of material having a lower expansion rate than the bolts.

The article further presents theoretical formulas covering complete analyses of the various types of joints.

High-Pressure Feed Pump

A design of high-pressure, high-temperature boiler feed pump developed by G. & J. Weir, Ltd., of Glasgow, is described in the June 20 issue of *Engineering*. The arrangement as shown in the sketch is designed to overcome stuffing-box difficulties. The impeller shaft is



Section through Weir pump

journaled in the bearing pedestal *p* and fitted with a renewable sleeve *l*. Integral with the pump casing is a water-lubricant chamber *c* in the outer wall of which is a stuffing box. The sleeve passes through this stuffing box and through a restriction ring *r* in the inner wall of the chamber. Water leaking from the casing through the annular orifice between the ring and the sleeve passes into the chamber *c* where, due to its high temperature, it rises to the top. Here it comes in contact with the tubes *t* and gives up heat to the water flowing through them. It then descends from the heat exchanger to the bottom of the chamber. The water lubricant in the chamber is at almost the same pressure as the water in

the pump casing and this pressure maintains a flow of cold water lubricant through the stuffing box where it cools the packing, then leaks past the stuffing-box gland to the atmosphere.

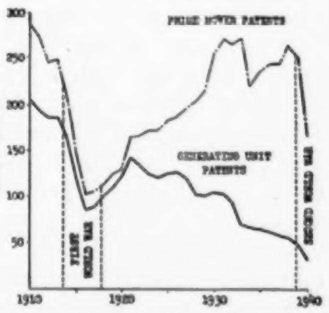
Radial High-Speed Steam Engine

H. Lentz, inventor of the well-known poppet-valve design of reciprocating engine bearing his name, has recently developed a six-cylinder radial steam engine operating on the uniflow principle. This is described in *Wärmewirtschaft und Dampfkesselwesen*, Vol. 22, No. 2. The pistons, which are single acting, are arranged radially around a single crank, similar to certain airplane gasoline engines, and because of the uniflow design there are no exhaust valves but merely ports in the cylinders. The inlet valves are double-seated and located to one side of the cylinder heads.

The engine is designed for steam conditions up to 430 lb gage and 752 to 932 F, condensing, at 2000 to 3000 rpm. According to Lentz, the engine is intended for driving individual axles of locomotives as well as marine use through reduction gearing.

Steam Patents and the War

In the July issue of *The Steam Engineer*, London, S. T. Madley draws attention to the phenomenal slump in patents relating to steam generating units and prime movers during the war-time period. During the first World War the provisions of the Patents and Designs Act, 1907, was inadequate to meet the war emergency and it was found necessary to improvise. Licenses were granted to work enemy patents, but the question of infringement by war-time working of them was not clearly defined. Late payment of patent fees and belated filing of Convention applications, because of the war, were also



British patents over thirty-year period

confused. A Board of Trade license governing trading with the enemy was introduced, and a heavy excess profits tax was imposed. In the Peace Treaty, Sec. 307 and 308 validated the late filing of Convention cases, and Sec. 309 guarded against war-time infringement of enemy patents.

When the present war started the Patents, etc., Emergency Act, 1939, was passed. This act empowers the Comptroller to grant licenses to work enemy patents, and to extend the time for doing any act regarding a patent which was impeded by the war.

Patent applications are about half what they would be in normal times, though it is believed that an avalanche of foreign applications await the end of the war to be filed.

REVIEW OF NEW BOOKS

Any of the books reviewed on these pages may be secured from Combustion Publishing Company, Inc., 200 Madison Ave., New York

Mechanical Engineers' Handbook Fourth Edition

Edited by Lionel S. Marks

Mechanical engineers will welcome the new 1941 Edition of this standard handbook, as eleven years have elapsed since the appearance of the previous edition and in the interim far-reaching advances have been made in many branches of mechanical engineering. Furthermore, because of the present design and construction activity in defense plants, the need for such information has been greatly widened.

The present volume represents the work of more than ninety contributors, each a specialist in the particular subjects covered, and many of the chapters have been completely rewritten, only basic material having been retained from the previous edition. The last ten years represent a period of active standardization and codes by engineering bodies and much of the more pertinent information on these has been included, although in order to keep the book within convenient size, certain specific information in such codes and standards that is readily available elsewhere, has been omitted.

Because of the breadth of the subjects covered a detailed and critical review is beyond the scope of this mention. It may be pointed out, however, that the editing, indexing and mechanical preparation of a book of this size and scope, involving 2274 pages of text, tables and illustrations, has required considerable time, in addition to the preparation of the material. Therefore, it is not surprising that some of the more recent developments of the past year and a half are not included. Moreover, the treatment is aimed at supplying needed information and data to mechanical engineers in general, rather than to designers of equipment who for the most part have available their own special design data.

The book has been kept to the same size page as former editions, namely, 5 × 7 in., is printed on thin stock and bound in flexible fabric. The price is $7.

Piping Flexibility and Stresses

By S. D. Vinieratos and D. R. Zeno

Until a few years ago the methods and extent of determining the flexibility and stress of steam piping in marine work were at best only an approximation. Pressures and temperatures were low and a wide margin of error was not as a rule considered serious. At the present time, however, the majority of ships being built in this country will use steam conditions of 450 lb or higher and 750 F at the superheater outlet; for naval work temperatures have gone up to 850 F and for the Maritime Commission in a few cases to over 900 F. This calls for heavier piping and provision for greater expansion and the old-time method of good judgment on the part of the draftsman can no longer be relied upon to meet present conditions.

The authors of this book demonstrate the use of the grapho-analytical method of superposition wherein the loading and bending moments are represented diagrammatically, and the effect of each force and moment is applied separately at the end of the pipe and then, by superposing their individual effects, arrive at their resultant total effect. Beginning with a simple problem of a piping lead with square corners, the method is developed to embrace a problem of intersecting piping in space with three anchorages. Slopes and deflections are dealt with at length with charts and diagrams, and illustrative moment and slope diagrams and tables are also given. Once the grapho-analytical method is thoroughly understood, it should prove an invaluable time saver for those who have to deal with such piping problems.

The book comprises 85 pages, size $7^1/_4$ × 10, with ring binding. Price $3.

Encyclopedia of Machine Shop Practice

Edited by Prof. George W. Branwell

In view of the appalling shortage of trained men to meet the needs of the National Defense program the "New Encyclopedia of Machine Shop Practice" edited by Prof. George W. Branwell of Stevens Institute of Technology is more than just another book or technical compendium of general information. Ordinarily it might be classed as such, but today, when defense begins at the bench, it should be of invaluable help to beginners and machinists alike engaged in defense work. It has nearly 1000 illustrations and diagrams, and covers 2800 up-to-the-minute items. For the benefit of the layman it is written in non-technical language.

Included in the contents are detailed explanations of the operation of such standard machine tools as the lathe, milling machine and centerless grinder. Gear cutting, heat treatments, forge and foundry work are also covered in easy informative style. The book begins with a complete home-study course on the use of hand tools, then covers the whole field of metal working by modern machinery, and ends with a 15-page index. It comprises 568 pages, size $5^1/_2$ × $8^1/_2$, and is bound in maroon buckram. Price, $1.98.

A.I.E.E. Special Publications

For the benefit of readers who have an interest in the electrical field, attention is called to two recent publications issued by the American Institute of Electrical Engineers. One of these is "Bibliography of Relay Literature." This is the first time since the issuance of the NELA "Relay Handbook" in 1926 that a composite reference list of the significant literature in the field of

protective relaying has been compiled. All available indexes have been reviewed and all pertinent material, including articles which appeared in the *A.I.E.E. Transactions* and *Electrical Engineering* from Jan. 1927 through Dec. 1939, and also most of those in the chief technical publications in the electrical field from Jan. 1932 through Dec. 1939, have been listed. This 16-page pamphlet, size $8^1/_2 \times 11$, is priced at 50 cents, or to A.I.E.E. members at 25 cents.

The second publication, entitled "Telemetering, Supervisory Control, and Associated Circuits" summarizes a wealth of information concerning the electric telemetering and supervisory-control systems currently in use or commercially available in the United States as of Dec. 1940, and includes a detailed discussion of the interconnecting circuits suitable for each purpose. In recognition of the fact that telemetering and supervisory control are finding their greatest potential field of application in nonelectrical industries, the report has been prepared in such form and terminology as to make it readily useful to engineers in any branch of industry likely to be concerned with the problems of remote measurement and control. Extensive tabulations giving comparative data are designed to enable a prospective or existing user of this type of equipment to determine quickly the type of apparatus best suited to his requirements. This 28-page pamphlet, size $8^1/_2 \times 11$, is priced at 80 cents, or to A.I.E.E. members at 40 cents.

Results of Municipal Electric Systems

Under this title the consulting engineering firm of Burns & McDonnell, of Kansas City, Mo., has just published the seventh edition (1941) of its book containing statistical information on 756 municipally owned electric systems located in the United States and two in Alaska. Although there are at present over twenty-four hundred such systems in this country, many of these are small and purchase electricity for distribution rather than generate it. The book covers 78.5 per cent of those serving communities having a population of more than 5000.

The data covers the type of plant (steam, diesel or hydro), capacity, maximum load, annual output, valuation, annual revenue, cost of production and rates charged for electricity. Numerous charts are included. It is significant that over half such systems have lowered their rates for electricity since the 1939 edition was brought out.

While the comments are decidedly pro-municipal ownership and operation, the data are factual and city officials, operators and managers of both private and municipal plants and systems will find these records of interest and value. The book contains 425 pages, 6×9 in., with plastic-ring binding and heavy paper cover. Its price is $5.

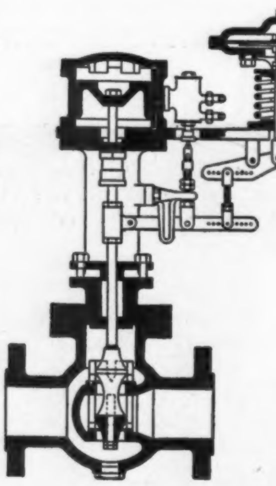
NEW EQUIPMENT

Automatic Temperature Indicator

As many as 50 couples can be used with the automatic temperature indicator announced by the Leeds & Northrup Company. All are individually connected to toggle-switches on the indicator front. To read a couple's temperature, the operator throws its switch, and a pointer moves automatically to the correct scale position. There are no dials to turn or galvanometer to watch. The instrument automatically performs these operations, leaving the operator's hand free to make notations.

Pressure-Reducing Valve

Northern Equipment Co. announces an improved design of the Copes Type R-DSLH pressure-reducing valve, a relay-operated unit used for remote control from a master controller. The principal changes have been in the mounting of the diaphragm operator receiving pressure impulses from the master, and in the linkage by which diaphragm movement is transmitted to the relay operator of the



valve. These parts have been strengthened and arranged more compactly to assure more rugged installation and more accurate installation. The valve can now be furnished in sizes from 1 to 14 in. and in all pressure standards from 125 to 1500 lb.

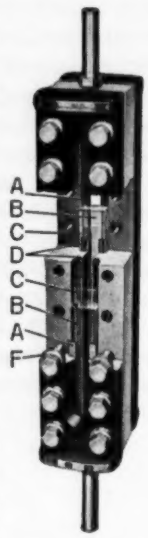
Steam Traps

New additions to its standard line of "side inlet" steam traps are announced by Armstrong Machine Works. These are designated in the 800–1000, 1600–2000, 3000–4400 lb per hr capacity range.

All of the new traps are built for operation on pressures up to 250 lb gage and are equipped with the standard Armstrong all-stainless steel inverted bucket operating mechanism. They are available with blast type thermic air vent buckets and internal type check valves as optional extra equipment.

Improved Water Level Gage

The Yarnall-Waring Company announces its improved pressure-sealed flat-glass insert for boiler water level gages. Built for pressures up to 1500 lb, the outstanding features of the improved design are pressure-sealed gaskets on inside faces of glasses and special spring-loaded cap screws holding down front and back cover plates.



Referring to sectional illustration, cushion gaskets (*A*) are used on outer faces of glasses (*B*). Thin sheets of India ruby mica (*C*) protect inner surfaces of the flat glasses from etching action of steam and water. The special pressure-sealed molded Vulcabeston gaskets (*D*) fit into body recesses on pressure side of glasses and provide tight joints between body and glasses without excessive tightening down of covers, thereby prolonging the life of these flat glasses in high-pressure service. Special shouldered cap screws are used to fasten cover plates to body. Spring cones (*F*) attached to each cap screw limit the amount of pressure on glasses and gaskets, take up expansion and contraction and allow for slight variations in thickness of covers, glasses and gaskets.

G-E Arc Welderule

Engineers, operators and others will welcome the use of the new General Electric Arc Welderule because of the time it saves in estimating electrode requirements. The Arc Welderule is of vest pocket size and reads directly the length of arc welded joints obtainable per 100 lb of electrode, also the pounds of weld metal deposited per 100 lb of electrode. The information covers eleven commonly used sizes and types of joints; also twenty-two sizes and types of popular electrodes in both the 14- and 18-in. lengths. An additional feature is a selector chart which shows the various filler metal classifications as specified by the American Welding Society and the types of electrodes which meet these classifications.

Fans for Heating and Ventilating

B. F. Sturtevent Company has developed a new fan known as the Silentvane Design 8 for heating, ventilating and air-conditioning which is characterized by its quietness of operation and low outlet velocity. It is designed for a maximum tip speed of 9000 fpm and mechanical efficiencies in excess of 70 per cent over 48 per cent of the performance range and in excess of 75 per cent over 35 per cent of the performance range are claimed. The fan is available in all standard discharges, single and double width, single and double inlet, with wheel diameters ranging from $12^1/_4$ in. to $87^3/_4$ in.

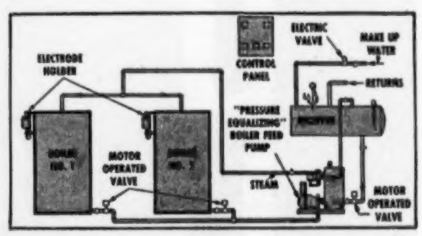
Semi-Refractory Cement

A new air-setting semi-refractory cement for protecting insulation exposed to the erosive action of hot gases has just been announced by Johns-Manville. The new material, No. 678 Semi-Refractory Cement, sets quickly without the application of heat, and was developed especially for use over flue, breeching and stack linings, where it is often impossible to introduce heat for some time after the cement has been applied. It is a fibrous, hydraulic-setting material having a minimum covering capacity of 20 sq ft 1 in. thick, per 100 lb. A high resistance to moisture and corrosive acid vapor is claimed and it does not shrink in area during setting, thus minimizing any tendency to crack. Under temperature the set material shows a maximum linear shrinkage of approximately 2 per cent at 1800 F. The cement is applied in a single coat, normal setting time being 16 to 24 hr and is furnished in 50-lb waterproof bags.

Water Control for Multiple Boiler Installations

A new system of water level control for two or more boilers with just one feed pump, has been announced by the Johnson Corporation. The system is electrically controlled, automatic in operation, and suitable for pressures up to 150 lb for boilers up to 250 hp.

Two stationary electrodes, of different lengths, are mounted in a small holder on each boiler. When the water level in any boiler falls below the longer electrode an electric circuit is disturbed which, through a relay, starts the boiler feed pump. At the same time a motor-operated valve is opened to divert the pump discharge into the boiler requiring water. When the water reaches the desired level the pump stops. When necessary all boilers can be fed simultaneously. Low-water alarm or low-water cutoff of stoker or burner can also be provided for each boiler.



The diagram shows the multiple boiler water control as used with the Johnson "pressure equalizing boiler feed pump." Boiler pressure is admitted to the suction side of the pump during its operating cycle. As a result it is not necessary to pump against boiler pressure, but merely to lift the water against the low static head. This enables the pump to handle condensate at higher temperatures without danger of vapor locking.

Demand, Production and Stocks

The Bituminous Coal Division of the Department of the Interior reports that, although the rate of production and storage of bituminous coal has improved within the past two months, there is still cause for concern over the possibility that emergencies may occur which might cause consumers' coal shortages.

Coal is being produced at a rate averaging approximately 10,600,000 tons weekly. This rate, which is greatly in excess of last year's, appears sufficient to meet estimated requirements that run in excess of 500,000,000 tons for 1941 if it can be maintained. It is subject, however, to heavy seasonal increases which may arise during the fall and call for peaks in production at the rate of 11,000,000 to 12,000,000 tons weekly. If such a production peak should continue for a substantial period, the Bituminous Coal Division believes that, in view of the already tight transportation situation, a serious coal problem may be presented.

While industrial plants, in general, are increasing the size of their stock piles, such stocks are not evenly distributed. That is, certain classes of consumers have far in excess of 35 days' supply while others are depending on almost day-to-day delivery to meet their fuel requirements; and any interruption in the continuous flow of their ordinary supply of coal, due to transportation or other difficulties, might find a great many of the smaller industrial plants without sufficient coal.

The stocks and consumption of bituminous coal through July, as issued by the Division on September 6, are as follows:

	July 1941 (Preliminary)	June 1941 (Revised)	Per Cent of Change
STOCKS, END OF MONTH, AT:	Net tons		
Electric power utilities[a]	10,431,000	9,988,000	+ 4.4
By-product coke ovens[b]	6,215,000	5,913,000	+ 5.1
Steel and rolling mills[c]	723,000	720,000	+ 0.4
Coal-gas retorts[c]	284,000	225,000	+26.2
Cement mills[b]	634,000	559,000	+13.4
Other industrials[d]	15,160,000	13,240,000	+14.5
Railroads (Class I)[e]	7,001,000	6,604,000	+ 6.0
Total industrial stocks	40,448,000	37,249,000	+ 8.6
Retail dealer stocks	6,600,000	5,680,000	+16.2
Grand total	47,048,000	42,929,000	+ 9.6
CONSUMPTION BY:			
Electric power utilities[a]	5,220,000	5,135,000	+ 1.7
By-product coke ovens[b]	7,107,000	6,855,000	+ 3.7
Beehive coke ovens[b]	908,000	886,000	+ 2.5
Steel and rolling mills[c]	833,000	827,000	+0.7
Coal-gas retorts[c]	128,000	127,000	+ 0.8
Cement mills[b]	660,000	615,000	+ 7.3
Other industrials[d]	8,860,000	8,860,000	—
Railroads (Class I)[e]	7,799,000	7,576,000	+ 2.9
Total industrial	31,515,000	30,881,000	+ 2.1
Retail dealer deliveries	6,000,000	5,390,000	+11.3
Grand total	37,515,000	36,271,000	+ 3.4
ADDITIONAL KNOWN CONSUMPTION:	Net tons		
Coal mine fuel	310,000	306,000	+ 1.3
Bunker fuel, foreign trade	125,000	127,000	− 1.6
DAYS SUPPLY, END OF MONTH, AT:	Days supply		
Electric power utilities	62 days	58 days	+ 6.9
By-product coke ovens	27 days	26 days	+ 3.8
Steel and rolling mills	27 days	26 days	+ 3.8
Coal-gas retorts	69 days	53 days	+30.2
Cement mills	30 days	27 days	+11.1
Other industrials	53 days	45 days	+17.8
Railroads (Class I)	28 days	26 days	+ 7.7
Total industrial	40 days	36 days	+11.1
Retail dealer	34 days	32 days	+ 6.3
Grand total	38 days	35 days	+ 8.6

[a] Collected by the Federal Power Commission.
[b] Collected by the U. S. Bureau of Mines.
[c] Collected by the Bituminous Coal Division.
[d] Estimates based on reports collected jointly by the National Association of Purchasing Agents and the Bituminous Coal Division from a selected list of 2000 representative manufacturing plants. The concerns reporting are chiefly large consumers and afford a satisfactory basis for estimate.
[e] Collected by the Association of American Railroads. Includes powerhouse, shop and station fuel.

NEW CATALOGS AND BULLETINS

Any of these publications will be sent on request

Automatic Combustion Control

A new 12-page bulletin DR-40 has just been issued by the Hagan Corporation, featuring its line of automatic combustion control instruments as applied to the larger type steam generating plants. It describes the function and need for automatic control, and gives examples and layouts of typical installations for boilers using different types of fuel. Numerous half-tones illustrate the control panels and cut-away views show individual parts.

Feedwater

"Feedwater Chemistry" is the title of a 12-page booklet issued by the Cochrane Corporation which deals with the fundamental reactions involved in water softening. Particular attention is called to "Ionic analysis" and "equivalents per million" methods of reporting, since these methods of interpreting water analysis are coming into more general use. The principles of its use are relatively simple and are clearly set forth in this booklet.

Heat Insulation

A 4-page illustrated bulletin has been issued by the Union Asbestos and Rubber Company describing its line of Unibestos blocks, sheets and sectional pipe covering. It is claimed that this product represents a radical departure in insulating materials for high-temperature service. Insulating data are given for pipe sizes up to 18 in. and for temperatures up to 1025 F.

Insulating Refractories

A 4-page bulletin by Plibrico Jointless Firebrick Company announces its new product "Plicast" L-W-1. This is a lightweight insulating castable refractory and is applicable for service temperatures as high as 2200 F. Very low thermal conductivity is claimed for this product which is specially suited for lining inspection doors of furnaces, rear doors of fire tube boilers, tube decks, water walls, ducts and breechings, etc., and for oil and gas burner installations.

Magnetic Variable-Speed Drive

The Electric Machinery Manufacturing Company has issued a 12-page bulletin ("E M Synchronizer," Vol. 5, No. 1) dealing with a new line of magnetic variable-speed drive, applicable to boiler plant operation. This drive utilizes a single-speed electric motor for motive power, and provides adjustable wide range fan output by interposing a compact self-contained magnetic-drive unit between the motor and the fan. The principle and construction of this unit are described and illustrated and comparative performance charts are given.

Measurement and Control

Republic Flow Meters Company has issued a 16-page catalog, No. 41-1, covering its wide range of control systems and many types of indicating and recording instruments. These include CO_2 meters, draft, pressure, liquid level and multiple reading instruments. Desuperheaters and regulating valves are also described. Each item is illustrated and accompanied by a brief description of its applications.

Vibro Insulators

The B. F. Goodrich Company has just published a 12-page catalog dealing with its line of Vibro-Insulators. It discusses the problem of vibration insulation and the part that rubber plays in the solution. Applications of the mountings on various types of equipment are listed, together with a table of characteristics. Nine pages, are devoted to the fundamental data for each type of mounting.

Turbine-Generators

An attractive and informative 78-page publication by the General Electric Company deals with the design and manufacture of turbine-generators in sizes from 500 to 7500 kw. Descriptive text is supplemented by many line drawings and half-tones showing every detail, and the various steps in manufacture and assembly are shown by numerous photographs. Printed on heavy coated stock with ring binding, the book is a most useful addition to turbine literature.

Personals

W. B. Broadbent has recently been appointed superintendent of the Operating Department, Southern Division, of the New England Power System, with headquarters at Providence.

A. A. Browne, steam engineer with Westinghouse Electric & Mfg. Company for the past two years, has been appointed assistant manager of the company's central station and transportation divisions for the Pacific Coast District with headquarters in San Francisco.

N. M. Barnett has been placed in charge of Bailey Meter Company's Detroit Branch Office, recently established in place of representation by resident engineers.

Howard M. Hubbard became the new president of the Elliott Company, Jeannette, Pa., on September 1. He came to this organization from the Greenfield Tap and Die Corporation, of Greenfield, Mass., where he had been president and general manager, and previous to this had served in various executive capacities with the Harris-Seybold-Potter Company of Cleveland, Ohio. He is a graduate in mechanical engineering of Northwestern University in Boston and also attended Massachusetts Institute of Technology.

Leonard F. Lang has joined the newly organized Power Plant Department of Western Precipitation Corporation, Los Angeles, and will make his headquarters in Chicago. He first entered the combustion field in 1917 in the Engineering Department of the Underfeed Stoker Company, was later connected with Combustion Engineering Company and the Riley Stoker Corporation, and for the past twelve years has been associated with the Detroit Stoker Company. This background of experience especially fits him for his present work in fly ash and dust control.

O. A. Soderberg, according to an announcement by D. S. Walker, Vice President in Charge of Sales, has been transferred from the Philadelphia District Office of Combustion Engineering Company, Inc., to become manager of the Detroit District Office, a place left open since W. J. Vogel was transferred to New York as Executive Engineer. A graduate of Yale University, M.E. 1917, Mr. Soderberg spent some time with the Winchester Arms Company during the World War and later enrolled in the schools conducted by the Navy in marine engineering and in turbines at Stevens Institute and Carnegie Tech., respectively. From 1920 to 1932 he was employed by Griscom-Russell Company in engineering and sales work and, prior to joining Combustion Engineering Company, he was with the Sun Oil Company. **James Page** and other sales engineers of the Detroit Office will continue to devote their time to their respective lines of contact, and it is anticipated that the new set-up and amplified staff will enable the Company better to serve the increasing business in this district, resulting in part from the defense activities.

(*Continued from page 44*)

steam flow and reaches the new value ahead of the steam but during the period of change approximately the correct amount of air is provided.

The "peaks" on the oxygen chart are present because the fuel is supplied in excess for short periods when the load is picked up and a deficiency exists when the load is dropped off. This unbalance is brought about because quick changes cause the mill level to vary above or below the normal level for short periods.

Speed of Feeder Controller

The foregoing discussion explains the cause of variations in the oxygen record when the load is changing but does not account for the variations when the rating is constant.

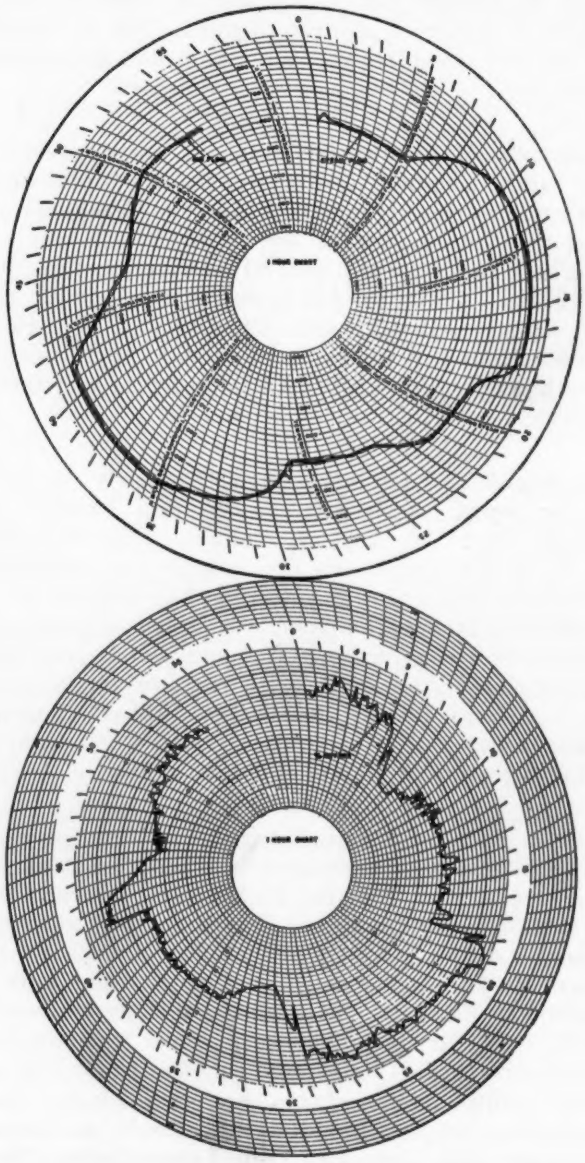


Fig. 5—Comparison of steam flow-air flow and oxygen record after adjusting speed of fuel-feeder controller

A comparison of steam-air flow and oxygen records before and after shortening the period of the feeder controller cycle is shown in Fig. 4.

This fuel-feeder controller operates with an "on" and "off" cycle. In the first case the speed of the cycle was

approximately half the speed in the latter case, both in the nature of seconds. The improvement in the chart is very noticeable, the last record being considered satisfactory operation.

Hence, the difficulty encountered with variations in oxygen (Fig. 1), for controlled fuel feed, has been eliminated by changing the speed of the feeder cycle. The analysis of this condition was made possible by the high-speed chart.

After adjusting the speed of the fuel-feeder controller, the comparison of steam-air flow and oxygen chart are shown in Fig. 5. The steam and air flow are proportioned with the air coinciding with the steam flow.

Note the improvement in oxygen record. However, the deficiency of air on an increase in rating is probably more apparent than on the previous charts. The length of time required to restore this is the entire interval required to accomplish the load increase. Likewise, when the load is dropped an excess of air or deficiency always exists on the boiler when the steam and air are made to coincide.

If the change in rating is compared with the oxygen chart, it is apparent that the final "desired value" of oxygen is in agreement only when the steam-air flow reaches its maximum or minimum.

Demand Estimates Revised Upward

Continued upward revision by utility systems of their previous estimates of 1941 peak loads is cited in the Federal Power Commission's tenth report on "Electric Power Requirements and Supply in the United States," issued on August 28. This summarizes in tabular form the actual electric energy and capacity requirements, by power supply areas during May and presents summaries of forecasts for June, July and August. The energy requirements for May were 13,066,847,000 kw-hr and the corresponding peak demands 26,198,065 kw.

The assured capacity as of May 31, 1941, was 30,664,497 kw, or 277,723 kw more than that reported for April. Capacity additions during May totaled 241,700 kw, the remainder of the increase resulting from upward revision of the dependable capacities.

The net assured capacity now reported as scheduled to be in service by the end of 1941 is 33,014,942 kw and by the end of 1942, 36,058,422 kw. These figures represent increases of 116,073 and 80,903 kw, respectively, over those previously reported and are due largely to advancing the scheduled dates of operation of several new generating units from the early months of 1942 and 1943 to December 1941 and 1942, respectively. Nearly all the new generating capacity now being ordered is scheduled for operation in 1943 or later.

Stream flow conditions throughout much of the East have been below normal for the past year as a result of which hydro generation has been seriously affected in many sections, particularly in the southeastern states and in New England. Therefore, the report points out, continued subnormal stream flow will affect the dependable capacity of those systems having a considerable amount of hydroelectric generating capacity and will result in a lowering of the previous estimates of those systems' dependable capacity. It will also place a greater burden on steam plants.

Coming Meetings

American Welding Society

The Twenty-Second Annual Meeting of the American Welding Society will be held at the Bellevue-Stratford Hotel, Philadelphia, October 19 to 24. Although welding in defense production will be the keynote of the meeting, the sixty-five technical papers to be presented will cover much of the whole welding field including piping and pressure vessels which will be discussed on Friday morning, October 24.

Annual Water Conference

The Engineering Society of Western Pennsylvania will hold its Second Annual Water Conference in the Urban Room of the William Penn Hotel, Pittsburgh, on November 3 and 4.

A.S.M.E. Fall Meeting

The regular Fall Meeting of the American Society of Mechanical Engineers will be held at the Brown Hotel, Louisville, Ky., October 12 to 15. Among the papers dealing with power subjects will be "Evolution of Furnace and Superheater Design," by W. J. Vogel; "Watts Bar Steam Power Station of TVA," by G. B. Rich and R. T. Mathews; "Methods of Estimating Circulation in Steam Boiler Furnace Circuit," by A. A. Markson, T. Ravese and C. G. R. Humphreys; "Causes of Mortality of Smoke-Abatement Campaigns," by Thomas A. Marsh; "Essentials of a Smoke-Abatement Program," by H. K. Kugel; "Flood Protection of Canal Street Station," by A. G. Rosenbaum; "Turbines for Power Generation From Industrial Process Gases," by John Goldsbury and J. R. Henderson; and "The Corrosion of Unstressed Specimens of Steel and Various Alloys by High-Temperature Steam," by H. L. Solberg, G. A. Hawkins and A. A. Potter.

Safety Congress

The Thirtieth National Safety Congress and Exposition will be held at the Stevens Hotel, Chicago, Oct. 6 to 10. An extensive program of symposiums, papers and discussions will deal with the twenty-five individual sections of the National Safety Council, representing practically all the major lines of industry. Three sessions will be devoted to safety problems among utilities.

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